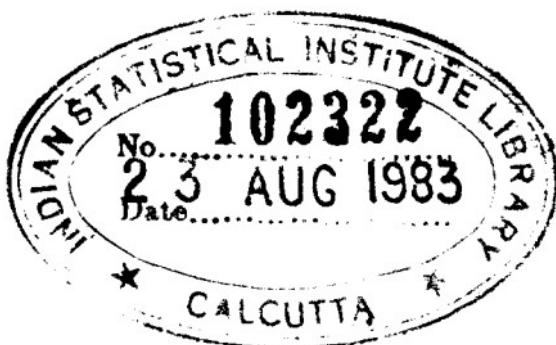


NATIONAL BIOGRAPHY

PRASANTA CHANDRA MAHALANOBIS

PRASANTA CHANDRA MAHALANOBIS

A. Mahalanobis



National Book Trust, India
New Delhi

₹12.50



1983 (Saka 1905)

© A. Mahalanobis, 1983

Rs. 6.75

Published by the Director, National Book Trust, India, A-5 Green Park
New Delhi-110016 and printed at Jagowal Printing Press, 7/15, Kirti Nagar
New Delhi-110015.

P R E F A C E

In this biography, I have attempted to cover as many aspects of the life and work of Professor Prasanta Chandra Mahalanobis as possible. I have also given brief descriptions of the historical background and the environment in which he lived and worked, and have written about some of the eminent persons he was associated with. I realize that it is difficult to write the biography of a many-faceted personality that Professor Mahalanobis was with a very wide range of interests and activities spread over several years, but I do hope there has not been any major omission of any aspect of his life except with regard to details.

I must thank the National Book Trust for their interest in publishing a biography of Professor Mahalanobis and for their kind invitation to me to write the biography. The Indian Statistical Institute will complete fifty years of its existence in December 1981 and it is indeed a fitting occasion to bring out a biography of Professor Mahalanobis in the Golden Jubilee Year of the Institute he founded.

I remember with gratitude the kind help and encouragement I received from the late Shrimati Nirmal Kumari Mahalanobis. It was on her advice that I agreed to write the biography. My thanks are due to the many authors who had written articles on the life and work of Professor Mahalanobis which were published in *Samvadadhram*, the house journal of the Indian Statistical Institute, and particularly to the late Shri H.K. Sanyal whose life-sketch of Professor Mahalanobis published in *Samvadadhram*, though brief, contained a wealth of information of great value. I am indebted to Shri M. Neogi, who was in charge of the Library of the Indian Statistical Institute, for his kind help in providing me with reference materials whenever required. I am thankful to Shri S. Datta of the Indian Statistical Institute for typing the manuscript of the biography in a short time.

C O N T E N T S

	<i>Page</i>
<i>Preface</i>	v
1. Ancestral Background	1
2. Early Life, Education and Career	8
3. Marriage and Controversies in Brahmo Samaj	14
4. Association with Rabindra Nath Tagore	23
5. Contributions to Statistics and Planning	30
6. Tours Abroad, Honours, Awards and the Last Days	61
<i>Bibliography</i>	64

ANCESTRAL BACKGROUND

The Brahmins of East India

ACCORDING TO RECORDS of history which are often a conglomeration of facts and legends, the ancestral origin of the Mahalanobis family can be traced back to about the tenth century A.D. It is said that in the latter part of the tenth century King Adisura of Gauda (Bengal), who had married the daughter of King Chanraketu of Kanyakubja or Kanauj (near present Banaras), had requested King Chandraketu to send five high caste Brahmins from Kanauj to Bengal to perform certain vedic sacrifices, as no competent person was then available in Bengal for this purpose. There are different versions about the relationship between King Adisura and King Chandraketu and the circumstances under which the five Brahmins came to Bengal, but it is more or less an accepted fact that the Brahmins did arrive. The entire Brahmin community of Bengal today, with the exception of some minor groups like the Vaidikas, trace their descent from the five Brahmins who came from Kanauj.

It may be pertinent to digress a little and mention here that, centuries later, Prasanta Chandra Mahalanobis made a detailed analysis of the anthropometric data relating to some typical castes of India including the Brahmins of Bengal. One of his findings was that the Brahmins stand out prominently as the only caste in Bengal showing definite evidence of resemblance with those of the Punjab and also with the upper castes outside Bengal, and that they do not appear to have intermixed appreciably with the eastern tribes.*

The capital in East Bengal (now Bangladesh) of King Adisura

*Majumdar, R.C. : *History of Ancient Bengal*, G. Bharadwaj, Calcutta, 1971.

where he received the five Brahmins, was known as Vikrampur. The king gave the Brahmins extensive lands to settle down in Bengal. The place where the five (Sanskrit : *pancha*) Brahmins first set up their abodes came to be known as Panchasar.

Bhatta Narayan, the most famous of the five Brahmins and a great poet, happened to be the common ancestor of Raja Rammohun Roy, Maharshi Devendranath Tagore (father of Rabindranath) and Guru Charan Mahalanobis (grandfather of Prasanta Chandra).

The descendants of the five Brahmins brought by Adisura numbered about sixty during the reign of his grandson King Kshitisura. The King gave villages to all of them for residence and each Brahmin and his descendants were known by the name of the village where they lived. Thus, the residents of Mukhati village were known by the surname Mukhati or Mukh-opadhyaya by adding the word upadhyaya (meaning teacher) to the village name. In this way other titles like Bandy-opadhyaya and Chatt-opadhyaya were also formed. It was during the reign of King Vallalsena (1158-1179), the famous Sena King of Bengal who had his capital very close to Panchasar, that the Brahmins came to be known Radhiya and Varendra according to the places in which they settled. The ancestors of both Rammohun Roy and Guru Charan Mahalanobis were known as Radhiya Bandyopadhyaya.

Parasurama, twenty-second in descent from Bhatta Narayan and Rammohun Roy's fifth progenitor, came to settle in Murshidabad in the beginning of the eighteenth century. He is said to have received a high official post and the title of Raya (Roy) from Nawab Murshid Quli Khan during the reign of Emperor Aurangzeb. Since then, the descendants of Parasurama had been using the title or surname Roy in place of Bandopadhyaya.

Jagannath Kushari, a descendant of Bhatta Narayan, had married the daughter of Shukdev Roy Chowdhury who was a *pirali* Brahmin (a Brahmin of a lower order). Kushari's son Purusottam was the first progenitor of Devendranath Tagore. Panchanan, a descendant of Purusottam, left his home in the seventeenth century and came to stay in Govindapur, which is now a part of Calcutta. The traders of the locality used to address him as

Panchanan Thakur and this was the origin of the title Thakur which later changed to the surname Tagore.

The administrative divisions of Bengal were known as "mahals" during the Moghul period. There were about seven hundred mahals in Bengal during the reign of Emperor Akbar. Those who were entrusted with the job of keeping accounts of land and land revenue in each mahal were given the title of "Mahal-nobis" and thus the ancestors of Guru Charan, possibly six generations before him, started using the title or surname Mahalanobis in place of Bandyopadhyaya.

Guru Charan Mahalanobis

Guru Charan Mahalanobis was born in Panchasar in Vikrampur on 21 June 1833. His parents died when he was very young and he was brought up by his cousin and elder brother. He did not have the opportunity of a formal school or college education but that did not stop him from making a mark in later life. On the subdivision of his ancestral properties, Guru Charan had to leave his home at the age of twenty-one to seek a livelihood in Calcutta. A spirit of adventure and enterprise characterised the people of Vikrampur and Guru Charan was no exception. It was indeed a bold venture to leave one's home without any assets or anything to fall back upon and go to an unknown place. In those days the journey from East Bengal to Calcutta was quite hazardous and had to be undertaken in large boats sailing on crocodile-infested rivers flanked by tiger-infested forests. When Guru Charan Mahalanobis reached Calcutta in 1854 after a journey of fourteen days he had in his possession some clothes, a roll of bedding and only five rupees in cash. It was not difficult for Guru Charan Mahalanobis to find a job in Calcutta on a salary of seven rupees a month, and he could even save five rupees every month out of his salary, as board and lodging were provided free of cost by his employer.

On his arrival in Calcutta, Guru Charan Mahalanobis started enquiring about the Brahmo Samaj but was unable to get any information for one year. He, however, did not give up hope and ultimately succeeded in coming in contact with the Adi Brahmo Samaj. He also procured some old copies of the *Tattwabodhini*

Patrika (founded by Devendranath Tagore and first published in August 1843) and got a good deal of information about the Brahmo Samaj and also about books written by Rammohun Roy from them.

The Brahma Sabha (later called the Brahmo Samaj) was founded in 1828 by Raja Rammohun Roy, the pioneer of Indian renaissance. The Brahmo Samaj, which later became the spearhead of the renaissance in Bengal, had fallen into decay after the death of Rammohun Roy in 1833. The progressive movement was, however, revived under the leadership of Devendranath Tagore who was known as Maharshi (great sage) because of his deep piety.

In August 1861 Guru Charan Mahalanobis was initiated into Brahmoism by Devendranath Tagore, Keshab Chandra Sen, another leader of the Brahmo Samaj, had been initiated into Brahmoism a little earlier and given the name Brahmananda (bliss in Brahman) by Devendranath. Soon after his initiation, Guru Charan became a very active member of the Adi Brahmo Samaj and helped in the work of the Samaj till 1866.

In 1864, Guru Charan Mahalanobis married Rukmini Devi, a young widow who came from a very learned Brahmin family of Vikrampur. Iswar Chandra Vidyasagar's campaign in Bengal for the remarriage of widows had taken the land by storm and resulted in the enactment of the Remarriage of Widows Act of 1856 but the act remained inoperative as there was no social sanction. It was, therefore, left to some young reformers, who defied social ostracism, to take up the cause. Guru Charan Mahalanobis had always supported all social reforms which he considered just and progressive, and this movement, which was perhaps the most outstanding for the emancipation of women since the abolition of "suttee" in the days of Rammohun Roy, found a ready and ardent supporter in Guru Charan Mahalanobis. He immediately decided that he should marry a widow.

As stated earlier, Guru Charan Mahalanobis was an active member of the Adi Brahmo Samaj. In 1866 there was a conflict between the older and younger groups of Brahmos which could not be resolved. The younger group, which included Guru Charan Mahalanobis, broke away from the Adi Brahmo Samaj and

Maharshi Devendranath Tagore and founded the Bharatvarshiya Brahmo Samaj (changed later to Nava Vidhan Brahmo Samaj from 1880) under the leadership of Brahmananda Keshab Chandra Sen.

Keshab Chandra Sen was an outstanding personality and his lectures always drew very large audiences both in India and in England. He gave a new dimension to the Brahmo Samaj movement and, under his dynamic leadership, the Bharatvarshiya Brahmo Samaj forged ahead, particularly in the sphere of social, moral and educational development of the new generation not only in Calcutta but also in East Bengal and other parts of India.

Keshab Chandra Sen died on 8 January 1884 at the age of forty-five years. A few years before his death there was a second schism and a number of Brahmos including Guru Charan Mahalanobis dissociated themselves from Keshab Chandra Sen and the Bharatvarshiya Brahmo Samaj and established the Sadharan Brahmo Samaj. Guru Charan Mahalanobis was elected the first Treasurer of the Sadharan Brahmo Samaj.

Incidentally, mention may be made here of an important event which was to take place several years later. When the dissident group broke away from Keshab Chandra Sen in 1878, no one could perhaps imagine that one day Guru Charan Mahalanobis's son would marry a daughter of Keshab Chandra Sen. But that did happen when, almost twenty-five years later, Guru Charan Mahalanobis's eldest son Subodh Chandra married Monica Devi, fourth daughter of Keshab Chandra Sen in December 1902. The event was a memorable one inasmuch as it helped in a large measure to restore cordial relations between the Bharatvarshiya (Nava Vidhan) Brahmo Samaj and the Sadharan Brahmo Samaj.

After serving in different places in Calcutta, Guru Charan Mahalanobis ventured into independent business. He started trading in cloths in 1861 and had been doing well, but he soon found that the business gave ample opportunities for making large profits at the expense of honesty. He could have been a very wealthy man if he had stuck to his business but he realized the danger of this allurement and decided to close down business immediately. He then started a chemist's shop and a bookshop in July 1862, but

incurring losses on the bookshop had to close it. He, however, continued the business of selling medicines. His chemist's shop, known as Mahalanobis & Co., was first located at 14 College Square and later shifted to his own house which he built in 1883 at 210 Cornwallis Street (now Bidhan Sarani).

Guru Charan Mahalanobis was the first Brahmo to marry a widow. Later he helped a number of widows to get married and settled in life. He also helped students who came from East Bengal to study in Calcutta by providing them with shelter in his house for a few days before they could find lodging elsewhere. Guru Charan Mahalanobis started life from the scratch and worked his way up through self-sacrifice, courage and determination in the face of heavy odds. He not only established himself among the leaders of the Brahmo Samaj but laid the foundation of some outstanding social work which was to bear fruit in later years. Although not an educationist himself, his contribution towards the spread of education was not small. He rendered invaluable service in the establishment of three well-known educational institutions of Calcutta, the Brahmo Boys' School, the Brahmo Girls' School and the City School. He was elected President of the Sadharan Brahmo Samaj twice. He was also elected Secretary of the Samaj twice and its treasurer twenty-six times.

The Two Sons of Guru Charan Mahalanobis

Guru Charan Mahalanobis's two sons distinguished themselves in two different fields. The elder, Subodh Chandra Mahalanobis, in education and the younger Probodh Chandra Mahalaonbis (father of Prasanta Chandra) in business. Subodh Chandra Mahalanobis first joined the Calcutta Medical College but left for the United Kingdom in 1891 to continue his studies in medicine at the University of Edinburgh. After studying medicine for a few years, he took up the study of physiology and was engaged in research at Research Laboratory of the Royal College of Physicians. He wrote some textbooks on science and research monographs, all of which were published in the United Kingdom. He graduated from the University of Edinburgh and was later elected a Fellow of the Royal Society of Edinburgh in 1898. In the same year, he was

appointed Professor and Head of the Department of Physiology at the University of Cardiff (Wales). Subodh Chandar was the first Indian to hold the Chair of Physiology in a British University. On his return to India in 1900, he founded the Department of Physiology in the Presidency College in Calcutta, thus becoming a pioneer in the introduction of the teaching of Physiology as a separate discipline in non-medical colleges in India, because till then the subject had been taught only as one of the subjects for students studying medicine in medical colleges. He also founded the Post-Graduate Department of Physiology of the University of Calcutta and was the Head of this Department and President of the Board of Higher Studies in Physiology. He was elected a Fellow of the University and a Member of the Syndicate. Subodh Chandra, along with his wife and two sons, visited the United Kingdom again in 1909 to represent the University of Calcutta at the Darwin Centenary Celebrations held at the University of Cambridge.

Probodh Chandra Mahalanobis worked for a few years in his father's chemist's shop and then started a business as a dealer in sports goods, gramophones and gramophone records in partnership with Dr. (later Sir) Nilratan Sircar, the eminent physician, educationist and industrialist, whose sister Nirodbasini married Probodh Chandra in 1891. The concern, known as Carr & Mahalanobis (Carr was an abbreviation of Sircar), was situated at the crossing of Esplanade East and Chowringhee Road—two well-known thoroughfares of Calcutta—and near a busy shopping centre. Carr & Mahalanobis became the largest concern in Calcutta dealing in sports goods. It also catered to a large number of customers interested in buying the latest gramophone records. Incidentally, it may be mentioned here that it was through the earnest endeavour of Probodh Chandra Mahalanobis and Prasanta Chandra Mahalanobis that the attempt by the Gramophone Company of Calcutta to record the voice of Rabindranath Tagore for the first time was successful. It was in 1924 that twenty-eight records of songs and recitations by the poet were made in one day. Probodh Chandra Mahalanobis not only made Carr & Mahalanobis one of the leading and widely known business concerns of Calcutta but also helped many young men by providing them with jobs in this concern.

EARLY LIFE, EDUCATION AND CAREER

Early Life

IN THE EARLY morning of June 29, 1893, Prasanta Chandra Mahalanobis was born in the house built by his grandfather at 210 Cornwallis Street. He was the eldest of two brothers and four sisters. His mother died when he was fourteen years of age.

Mahalanobis had an analytical mind from an early age. As he grew up, he developed a distaste for everything conventional and a liking for everything that had a touch of originality. This characteristic became more pronounced in later years and his novel ideas were often looked upon as whims or idiosyncrasies. Even during his school days, he was interested in reading books on various subjects which were not strictly within the curriculum and passing examinations by reading textbooks did not seem to be his primary interest. An interesting incident, which showed his apparent unconcern for examinations, is said to have taken place when he was a student of the Presidency College, preparing for his Intermediate Examination in Science. It was customary that the students should get pass marks in all the subjects in the test examination of the college before they could appear for the final examination. Mahalanobis wrote two essays in the paper on English but did not bother to appear at the examinations in other subjects. The principal of the College was, however, so impressed by his two essays that he was allowed to appear at the final examination.

He showed glimpses of his organizing ability early in life by organizing literary circles, sports and dramas among his friends and associates. When he was hardly fifteen years of age, his acting in the role of Raghupati in Rabindranath Tagore's famous drama *Bisharjan* was considered outstanding.

Education in India and England

Mahalanobis had his early education in the Brahmo Boys' School founded in 1904 by his grandfather Guru Charan Mahalanobis. He passed the Entrance (later called Matriculation) Examination from this school in 1908. Mahalanobis passed the Intermediate Examination in Science in 1910 and the Bachelor of Science Examination with Honours in Physics in 1912 from the Presidency College, Calcutta.

He left for England in the summer of 1913 with the intention of studying in the University of London. While in London, he went to Cambridge on a day's excursion, missed the train and stayed with a friend for the night. The following day, it was by sheer chance that he got an opportunity to meet the Provost of King's College who told him that he could join King's College in October of that year. It was a pleasant surprise for him and he decided to join King's College and gave up his intention of studying in the University of London.

Mahalanobis was in Cambridge for about a year and eight months and, during this short period passed the Tripos Examination of the University of Cambridge : Part I in Mathematics in 1914 and Part II in Natural Science (Physics) in 1915. The course for Part II normally is extended for two years but he completed it in one year and got a taste of continuous hard work which he had never experienced before. In spite of long hours of study, he managed to find time for other activities such as social function and group discussions, excursions and cross-country walks on holidays and heated arguments with friends on various subjects.

In later life, Mahalanobis used to recollect the happy days of his undergraduate life in Cambridge and the pleasant time he had in the company of his friends. He remembered particularly S. Ramanujan, the great mathematician. Ramanujan had gone to Cambridge a little later than Mahalanobis, and was in the Trinity College, but within a few days of his arrival, they managed to get acquainted with each other and became close friends very soon. During a term in his second year in King's College, Mahalanobis had got rooms just below the rooms occupied by J.M. Keynes, the famous economist, who was then a brilliant young Fellow of King's

College. He never imagined at that time that he too would one day be elected an Honorary Fellow of King's College.

Mahalanobis and Ramanujan used to go out for long walks on Sunday mornings, during which their discussions ranged over a wide variety of subjects. Ramanujan had some progressive ideas about life and society but no reformist views. He would often speak of certain philosophical questions and a theory of reality based on the fundamental concepts of zero, infinity, and the set of finite numbers. Mahalanobis used to follow in a general way but could not clearly understand what Ramanujan had in mind. Ramanujan sometimes spoke of "zero" as the symbol of the Absolute (Nirguna Brahman) of the extreme monistic school of Hindu Philosophy, that is the reality to which no qualities could be attributed, which could not be defined or described by words and was completely beyond the reach of the human mind. According to Ramanujan, "zero" was the absolute negation of all attributes and "infinity" was the totality of all possibilities which could become manifest in reality and which was inexhaustible. As far as Mahalanobis could understand, Ramanujan was of the view that the product of infinity and zero would supply the whole set of finite numbers and each act of creation could be symbolized as a particular product of infinity and zero, and from each such product would emerge a particular individual of which the appropriate symbol was a particular finite number.*

Incidentally, it may be of interest to note that, about forty years later a somewhat similar philosophical thinking led Mahalanobis to trace certain interesting resemblances of the ancient Jaina philosophy to the probabilistic and statistical view of reality. He found that the Jaina logic of Syadvada, which was current over two thousand years ago, seemed to have a close resemblance to the concept of probability, and that all predictions, according to Syadvada, had a margin of uncertainty which was somewhat similar to the concept of uncertain inference in modern statistical theory.**

*Ranganathan, S.R.: *Ramanujan—The Man and the Mathematician*. Asia Publishing House, 1967.

**Mahalanobis, P.C.: "Foundations of Statistics", *Dialectica*, 8, 95-111, *Sankhyā*, 18, 183-194, 1957.

Ramanujan's facility in the theory of numbers was in large measure intuitive. Many of the results apparently came to his mind without any effort. To quote an incident: on one occasion, Mahalanobis went to Ramanujan's room to have lunch with him. Ramanujan was stirring something in a pan on the fire for their lunch. Mahalanobis was sitting near a table and turning over the pages of a copy of the *Strand* magazine which, at that time, used to publish a number of puzzles to be solved by the readers. He got interested in a problem involving a relation between two numbers. Two British officers were billeted in Paris in two different houses on a long street, the numbers of these houses were related in a special way and the problem was to find out the two numbers. It was not a difficult problem and Mahalanobis got the solution in a few minutes by trial and error. He then jocularly told Ramanujan, "Now here is a problem for you." Ramanujan said, "What problem, tell me" and went on preparing the food. Mahalanobis read out the problem from the magazine and Ramanujan promptly answered, "Please take down the solution" and dictated a continued fraction, the first term of which was the solution obtained by Mahalanobis and each successive term represented successive solutions for the same type of relation between two numbers, as the number of houses on the street would increase indefinitely. There were also other occasions when Mahalanobis was amazed at Ramanujan's genius as a mathematician.

As stated earlier, Mahalanobis completed the course for Part II of the Tripos in a short time. He did not expect that he would do well in the examination and his own assessment of his performance at the examination was pretty low. It was, therefore, a real surprise to him when the results were out; to find that he was the only candidate to get a first class in physics.

Congratulations poured in from all quarters and for once he felt that he was a very important person. Then followed the Convocation and the award of degrees and dinner for the first time at the high table with the Fellows of King's College. To crown it all, the King's College awarded a senior research scholarship to him. The following news was published in *The Indian Daily News*, a Calcutta newspaper, on 23 June 1915:



Indian Student's Success—News has been received by cable that Mr. Prasanta Chandra Mahalanobis, who, as already announced, obtained First Class Tripos in Physics, Part II, in Cambridge this year, has stood first in the University Examination and has been awarded the research scholarship of £80 a year. Mr. Mahalanobis, who is a young man of about 21, is a nephew of Prof. S.C. Mahalanobis of the Presidency College, Calcutta.

Even before the Part II Tripos Examination had started, Mahalanobis had decided to stay in Cambridge during the long vacation between July and August and do research work in the famous Cavendish Laboratory under C.T.R. Wilson and Sir J.J. Thomson. At that time he came to know that the Peninsular and Oriental Line, a well-known shipping company, was offering a specially low concessional fare for students wishing to travel to India. Mahalanobis found that spending even a part of the vacation in India would be less expensive than staying in Cambridge. Further, travel to India would also give him the opportunity of looking up his relatives and friends who were eagerly awaiting his return. He, therefore, decided to return to India. He settled a research project with C.T.R. Wilson which was to be undertaken on his return to Cambridge and left England in July 1915.

- It was at King's College, Cambridge, that Mahalanobis first became interested in statistics. After the Part II Tripos Examination was over, he used to spend a good deal of time in the college library looking up various books and journals. One morning, his tutor W.H. Macaulay met him there and showed him some new bound volumes of the journal *Biometrika*. These had been presented to the library by its editor, Karl Pearson, an Honorary Fellow of the College. Macaulay asked Mahalanobis to have a look at the volumes and give his opinion. Mahalanobis got so interested in the books that he purchased a set of *Biometrika* which he brought to India when he came back. It was Macaulay who first drew the attention of Mahalanobis to mathematical statistics which led the latter to take up this subject for serious study.

Career

In India, while Mahalanobis marked time to return to Combridge

to continue his research in physics, his uncle Subodh Chandra Mahalanobis introduced him one day to Principal James of the Presidency College, Calcutta. Subodh Chandra Mahalanobis was held in high esteem not only in the Presidency College and the University of Calcutta but also among senior officials of the Government. Hence, the immediate effect of this introduction was that Principal James offered Mahalanobis a post in the Presidency College. A senior member of the teaching staff of the Physics Department had left India on war service and Mahalanobis was asked to take his classes. Mahalanobis, having accepted the post, gave up his idea of going back to Cambridge.

Mahalanobis was in the Presidency College for thirty-three years. Starting his career as Assistant Professor of Physics, he became Professor of Physics in the Indian Educational Service in 1922. He concurrently also held the post of Meteorologist in the Alipore Observatory in Calcutta from 1922 till he went abroad in 1926. Finding the volume of work in the meteorological office quite large, he suggested to the Government that there should be a separate post of meteorologist. This was created subsequently, and the post was offered to him. He, however, declined the offer as he preferred to work as the Professor and Head of the Department of Physics in the Presidency College. Mahalanobis was the Principal of Presidency College from 1945 till his retirement in 1948, and was made Professor Emeritus of the college after retirement.

In the meantime, he had laid the foundations of statistics in India and of the Indian Statistical Institute, which brought him worldwide recognition and renown.

MARRIAGE AND CONTROVERSIES IN BRAHMO SAMAJ

Controversy over Tagore

ON HIS RETURN from England, Mahalanobis did not lose time in choosing his future wife. The bride-to-be was Nirmal Kumari Maitra (more widely known by her nickname 'Rani') daughter of Heramba Chandra Maitra, an eminent educationist and a much admired and respected Principal of the City College, Calcutta.

The marriage, however, took place seven years later. This long wait was largely due to controversies over certain issues which had almost brought about another schism in the Sadharan Brahmo Samaj, and in which Mahalanobis played a prominent role.

The first issue was with regard to the proposal to elect Rabindranath Tagore as an honorary member of the Sadharan Brahmo Samaj. Divergent views were expressed, some in favour of, and some against, the proposal and there was a lot of confusion. The matter came to such an impasse that the President, the Secretary, the Assistant Secretary and some respected members of the Executive Committee of the Samaj tendered their resignation.

The confrontation was between the elders of the Samaj, representing the establishment, and the younger group. Mahalanobis and members of the younger group led by Sukumar Roy (father of the celebrated film director and artist Satyajit Ray and a brilliant scholar and a well-known writer of juvenile books) started canvassing support in favour of the election of Rabindranath Tagore. They addressed meetings not only in Calcutta but also in Giridih, Bihar, explaining why Rabindranath should be elected. Giridih, though a small town, was a popular health resort and, at one time, a stronghold of the Brahmo Samaj. It was visited by eminent personalities like Rabindranath Tagore and Jagadish Chandra Bose, Guru Charan Mahalanobis, Nilratan

Sircar, Heramba Chandra Maitra and many other important members of the Brahmo Samaj had their own houses in Giridih. Later, when the Indian Statistical Institute established a branch in Giridih, visitors to the place included many eminent scientists from abroad.

Besides addressing meetings, Mahalanobis brought out a printed pamphlet in Bengali for private circulation, under the title *Kano Rabindranathkay chai* (Why we want Rabindranath). In it he discussed in detail the objections raised against the election of Rabindranath. In the objections, specific mention was made of certain views of Rabindranath on such subjects as universalism, registration of marriages, preaching of religion, social reforms, emancipation of women and literature.

There was a general opinion that the Brahmo Samaj might lose its universal character by the election of Rabindranath because he considered the Brahmos only as a sect in the general body of Hindus. Mahalanobis quoted from writings of Brahmo leaders where it was stated that Brahmoism was both a universal religion and a form of Hinduism; it had a twofold aspect—that of universal religion to all nations and that of Hinduism to Hindus. He also quoted from Rabindranath's writings where he had said that a person could be a Brahmo, a Christian or a Muslim by religion but Hindu by nation.

Mahalanobis not only refuted each and every objection by cogent and even sarcastic replies but, in a final summing up at the end of the booklet, he observed that Rabindranath was building up a great ideal of universalism encompassing the entire humanity. The universalism of Rabindranath had not disregarded freedom or discarded the national character, nor had it sacrificed diversity. The central theme of Rabindranath's universalism was unity among diversity. The Brahmo Samaj had the same basic ideal. That was why the message of Rabindranath was the message of the Brahmo Samaj. Rabindranath's great ideal was manifest in his songs, poems, stories, novels, articles and religious discourses. The Brahmo Samaj had received a new inspiration by the influence of Rabindranath's living ideal.

The objections of the establishment of the Sadharan Brahmo Samaj to the election of Rabindranath appeared somewhat paradoxical, because, not only did the hymn book of the Brahmo Samaj comprise a large number of songs composed by Rabindranath, but, as Mahalanobis pointed out, the following resolution had been adopted by the Samaj on 20 November, 1913, that is eight years before the proposal to elect Rabindranath was made :

“Resolved that the Executive Committee of the S.B. Samaj offer their hearty congratulations to Babu Rabindranath Tagore on the unique distinctions he has won by obtaining the Nobel Prize for his Gitanjali and other works which are a noble expression of some of the most impressive aspects of the spiritual and ethical teachings of the Brahmo Samaj.”

Also, the following news had been published on 22 July, 1917 in the *Indian Messenger*, the organ of the Sadharan Brahmo Samaj :

“The Members of the Sadharan Brahmo Samaj assembled at Rammohun Library on Tuesday last to accord a warm reception to Sir Rabindranath Tagore. Babu Krishna Kumar Mitra, as President of the Sadharan Brahmo Samaj, welcomed Sir Rabindranath and paid a glowing tribute to the poet for delivering to the world through his speeches, writings, poems and songs the message of the Brahmo Samaj.”

The efforts of Mahalanobis and his supporters proved fruitful and, after some procedural delays, Rabindranath Tagore was duly elected an honorary member of the Sadharan Brahmo Samaj.

Controversy over Chhatra Samaj

The youth wing of the Samaj had, by then, became a force to reckon with and Mahalanobis and Sukumar Ray now turned their attention to a complete reorganization of the Chhatra Samaj (Students' Weekly Service). The Chhatra Samaj was established by Pundit Shivnath Shastri to provide a forum where the youth of all communities could meet to discuss social and other problems. Three essential conditions for membership in it were that a member should abstain from smoking, taking alcoholic drinks and witnessing dramatic performances on the public stage. These conditions were probably included in the membership pledge so as to prevent

the younger generation from drifting into waywardness. Mahalanobis was of the view that these clauses, which were negative in character and gave a sort of puritanical colour to the Chhatra Samaj, should be removed from the application form for membership. Incidentally, it may be mentioned that, even as late as in 1927, when Rabindranath Tagore's dance drama *Natir Puja* was staged, dancing in public by grown-up girls of cultured families was not in vogue. In fact, when a girl of a well-known Brahmo family first danced in a charity performance in the University Institute in Calcutta quite some time before the premiere of *Natir Puja*, it led a leader of the Brahmo Samaj to publish scathing criticisms against it in a newspaper edited by him. However, when *Natir Puja* was staged, the public were not only immensely impressed by the charm and dignity of the dance-drama, but the prejudice against grown-up girls taking part in songs, dances and plays disappeared completely from the public mind.

Mahalanobis and Sukumar Ray started a campaign for removing the negative clauses from the membership pledge and also for forming a permanent youth association on a broad base. In spite of opposition from those who misinterpreted Mahalanobis's view, the three clauses were removed and the Chhatra Samaj was reorganized. A conference of Brahmo youth was arranged in January 1917. The deliberations of which led to the formation of two Fraternities, one for literary and the other for social activities. Youths of all communities started joining the Fraternities in large numbers.

As there was not enough accommodation in his ancestral house on Cornwallis Street, Mahalanobis, on his return from England, had rented a house almost next door to it. Incidentally, Chintaman Dwarkanath Deshmukh (former Minister of Finance, Government of India), about whom more will be said later, had stayed in this rented house for some time with Mahalanobis in 1920. Deshmukh had then just joined the Indian Civil Service after a brilliant academic career, and had been introduced to Mahalanobis by a common friend. This was also the house where Mahalanobis used to recruit young men for enrolment in the Bengal Light Horse—a cavalry unit set up in Calcutta with the help of the Army during

the First World War to give military training to educated young men.

The meetings of the Fraternities were held on the roof of this house. Among those who were invited to these meetings were Rabindranath Tagore and Dr. (later Sir) Brajendranath Seal, who joined the young members of the Fraternities whenever invited, gave them company in various ways, and inspired high ideals in them. During one of the literary meetings, Rabindranath read out his famous book *Muktadhara*.

Objections to Civil Marriage Act

All these incidents in the Sadharan Brahmo Samaj perturbed Heramba Chandra Maitra. It was now difficult for him, as a respected member of the Samaj, to whom principles were above everything else, to feel enthusiastic about the growing attachment between his daughter and Mahalanobis and to give his consent to their marriage. In the meantime, another almost insurmountable difficulty arose when Mahalanobis made it known that he would not have his marriage registered under the Civil Marriage Act.

The first intercaste marriage took place in the Brahmo Samaj in August 1864. Since then, more intercaste marriages had started taking place in the Samaj, which caused a terrific agitation in the orthodox Hindu society. Opinion about the validity of such marriages was sought by the Brahmo Samaj from T.H. Cowie, Advocate-General of Bengal. Cowie was of the view that Brahmo marriages, not having been performed with Hindu or Mohammedan rites of orthodox regularity and not conforming to procedure prescribed by any law or to the usages of any recognized religion, were invalid.

In July 1868, in a meeting held at the Bharatvarshiya Brahmo Samaj and presided over by Keshab Chandra Sen, it was decided to approach the Government for enacting a law for Brahmo marriages. Keshab Chandra Sen went to Simla and placed the appeal of the Brahmo Samaj before the Government. In consideration of this appeal, Sir H.S. Maine, Law Member, Viceroy's Executive Council, presented a draft Civil Marriage Bill before the Legislative Council. The draft Bill contained a form of declaration

to be given by every person wishing to get married according to provisions of this Bill. It read : "I do not profess the Christian religion, and I object to be married in accordance with the rites of the Hindu, Mohammaden, Buddhist, Parsi or Jewish religion." The Bill, which was a purely Civil marriage Bill, met with considerable opposition from all quarters and had to be kept in abeyance. In 1871, Sir Fitzjames Stephen (who succeeded Sir H.S. Maine as Law Member) amended the form of the declaration to read : "I am a member of the Brahmo Samaj", and presented a Bill exclusively for Brahmo marriages. On the day the Bill was to be passed, a petition was submitted by the Adi Brahmo Samaj, objecting to the Bill on three main grounds : (a) the Bill would be imposing a civil form of marriage quite inconsistent with its religious spirit, (b) legislative interference was not needed in regard to the regulation of social customs, and (c) the Brahmos formed an integral part of the Hindu community and the Bill, if passed, would dissociate the former from the latter and check the course of healthy and spontaneous reformation which was the aim of the Samaj to bring about. As a result of the objection from the Adi Brahmo Samaj, the Bill was once again amended and took the form of a Civil Marriage Bill in which the declaration to be given was : "I do not profess the Christian, Jewish, Hindu, Mohammaden, Parsi, Buddhist, Sikh or Jaina Religion." The Special Marriage Act III of 1872 was passed on 22 March 1872.

A number of Brahmos took advantage of the clause giving retrospective effect to the Act (which was later repealed) to get their marriages registered under the Act. The Act was supported possibly because of its provisions for the right to divorce and the prevention of bigamy and early marriage. It became almost an essential part of Brahmo marriages since the establishment of the Sadharan Brahmo Samaj. On the other hand, there were others including many leaders of the Brahmo Samaj who did not consider registration of marriages under the Act essential. Keshab Chandra Sen considered registration under this Act as an irrelevant part of Brahmo marriages as the Act gave marriages an entirely civil status as opposed to the sanctity of a religious status. In 1871, the Bharatvarshiya Brahmo Samaj published a pamphlet about

the Special Marriage Bill in which it was stated that the Bill was entirely of a permissive character and sought to legalize marriages between Brahmos when solemnized in accordance with the provisions of this Act, but the Act did not say that marriages would be illegal if otherwise solemnized.

The main objections of Mahalanobis to have his marriage registered under the Special Marriage Act were : (a) since Brahmoism was based on the Upanishads, which formed an integral part of Hinduism, it would be incorrect for him to declare that he did not profess the Hindu religion; and (b) marriages contracted according to Brahmo marriage rites were legally valid and therefore, registration under the Act was redundant. Incidentally, it may be mentioned that the Privy Council had held that a Hindu by becoming a Brahmo, did not cease to belong to the community in which he was born. Mahalanobis, therefore, not only married without registration but, soon after his marriage, wrote and published a pamphlet in Bengali entitled *Brahmo Bibaha Bidhi* (Law for Brahmo Marriage). In it he traced the history of the attempts made to enact a separate law for Brahmo marriages and quoted extensively from the opinions of eminent jurists who supported the legal validity of Brahmo marriages without registration under the Civil Marriage Act. He had also made out a strong case for a system of recording marriages in the Samaj itself, giving details of the procedures to be followed.

If it were difficult for Heramba Chandra Maitra, as a supporter of the tenets of the Sadharan Brahmo Samaj, to agree to give his consent to a marriage without registration, it was equally difficult for Mahalanobis to have his marriage registered under the Civil Marriage Act. So, time hanged heavy and there secured no solution in sight.

The Wedding

Then Nirmal Kumari fell very ill and was advised to take complete rest in bed. Mahalanobis had an idea. Rabindranath Tagore's book of poems *Lipiaka*, written in 1919—the year Rabindranath renounced his knighthood—was still in the manuscript stage and had not been published till then. Mahalanobis went to Shanti-

niketan, copied the entire manuscript of *Lipika* throughout the night and brought the copy to Calcutta. He then did a daring act. Armed with the copy of *Lipika*, he went straight to Nirmal Kumari and started reading out the poems to her. Fortunately for him, there was no one at the door to tell him not to enter the house. Thus, an ingress was made into the house of his future father-in-law, and the strategy did prove effective.

Heramba Chandra Maitra was a man of strong principles but with a heart full of loving kindness. He did not, evidently, wish to express his feeling of disapproval permanently by standing in the way of his daughter's free choice of a husband. For, some time later, he told Nirmal Kumari that she and Prasanta Chandra had proved the sincerity of their devotion to each other, and that they had his consent to their marriage. He, however, told her that neither he nor her mother would be present at the wedding. Though it was rather unfortunate, the situation had to be faced. In the absence of her father, it was decided that the bride would be given away by Prasanta Chandra's maternal uncle, Sir Nilratan Sircar, and the wedding would take place at his residence at 7 Short Street.

The marriage of Prasanta Chandra and Nirmal Kumari took place on 27 February 1923. The service was conducted according to Brahmo marriage rites by Satish Chandra Chakravarti, a revered minister of the Sadharan Brahmo Samaj. The hymns at the wedding were sung by Dinendranath Tagore (nephew of Rabindranath), Suprobona Devi (wife of Sukumar Ray) and Sahana Devi, who were all famous exponents of Tagore songs. The same day, the premier of Rabindranath Tagore's latest opera *Basanta* took place at the Calcutta University Institute auditorium. Tagore himself, accompanied by Dinendranath and other well-known artists from Calcutta and Shantiniketan, took part in the opera.

After the performance, Rabindranath Tagore and the entire troupe attended the wedding and the ceremony began at about ten o'clock in the night. After the wedding ceremony Tagore came and sat in front of the bride and bridegroom. The poet's face was lit up with joy and his mind was full of the songs of spring which had been sung earlier at the opera. In sheer delight he began singing

the songs one after another without waiting for requests. The following day, when Prasanta Chandra and Nirmal Kumari went to pay their respects to Rabindranath Tagore, the poet gave them the bound manuscript of all the songs of the opera *Basanta* as a wedding present. He told them that as the premiere of the opera had taken place on their wedding day, they alone had the right to the manuscript. On opening the volume, Nirmal Kumari found written on the first page in Bengali :

Prasanta, Rani,
 tomader eyi milon basantay
 dilen Kobi basanta gan ani
 sunder prem sajuk ananday
 poruk golayay soorer malakhani
 (In this spring of your union
 the poet brings the songs of spring;
 let beautiful love dress in joy
 and wear the garland of melody.)*

It was indeed a happy finale to a rather stormy drama of seven years.

*Translated by the author.



Prof. and Mrs. Mahalanobis with Rabindranath Tagore at the Alipore Observatory
residence of Prof. Mahalanobis in 1924.

ASSOCIATION WITH RABINDRANATH TAGORE

Early Ties with the Tagore Family

IT MAY BE said that a close association with the Tagore family had started from the time Keshab Chandra Sen and Guru Charan Mahalanobis were initiated into Brahmoism by Devendranath Tagore. Keshab Chandra's inclination towards Brahmoism had met with strong disapproval of his parents and relatives but nothing could daunt his determination. He left his father's house and came away with his wife to stay for some time in Devendranath Tagore's house. Thus the foundation was laid for a close tie between them and also between their sons and daughters.

Keshab Chandra Sen's house in Calcutta, known as Kamal Kutir (Lily Cottage), which was later given away as a gift by his eldest daughter Maharani Sunity Devi of Cooch Behar to the Victoria Institution for girls, was a well-known place. This was the house where Ramkrishna Paramhamsa visited on several occasions when Keshab Chandra was alive. Narendranath Datta (later Swami Vivekananda) also used to go to the house quite often to hear discourses by Keshab Chandra. After Keshab Chandra's death, his eldest son Karuna Chandra lived in this house and, among his close friends who frequented it were Rabindranath Tagore, poet Dwijendralal Roy and Maharaja Jagadindranath Roy of Natore (a celebrated musician). Monica Devi learnt many songs composed by Rabindranath Tagore and Dwijendralal Roy directly from them in this house. The association between the two families was further strengthened when a grandson of Devendranath Tagore married a granddaughter of Keshab Chandra Sen.

The association with Rabindranath Tagore continued even after Monica Devi married Subodh Chandra Mahalanobis in 1902 and came to stay in the house at 210 Cornwallis Street. The ties became closer when Prasanta Chandra Mahalanobis received the

affection and blessings of Rabindranath Tagore quite early in life.

As a small boy, Prasanta Chandra used to accompany his grandfather, Guru Charan Mahalanobis, to the house of Devendranath Tagore in Jorasanko in Calcutta. He had seen Rabindranath Tagore from a distance but, at that time, Devendranath appeared to him to be the most important person. Devendranath noticing this little grandson of Guru Charan Mahalanobis, once told Guru Charan that Prasanta Chandra should learn to memorize the slokas of the Brahmo religion. Devendranath Tagore then made arrangements for the boy to learn the slokas with the correct Sanskrit accent from Pundit Shibdhon Vidyarnava.

Prasanta Chandra started reading Rabindranath Tagore's story books for children almost from the time he got acquainted with the Bengali alphabets. Sometimes, his mother, who was very fond of Rabindranath's books, used to read out some poems to him. As he grew up, Prasanta Chandra saw Tagore's acting in his plays and also heard his lectures during the Swadeshi movement. He occasionally saw the poet and paid respects to him but the association then remained at the level of the ties between the two families.

Visits to Shantiniketan and Closer Association with Tagore

Mahalanobis's close association with Rabindranath Tagore started in 1910 when he first went to Shantiniketan. The place where Maharshi Devendranath Tagore founded the Shantiniketan Asram was originally a barren land and a haunt of robbers. Devendranath had chanced upon this place during one of his journeys and found it so attractive that he spent some time there in meditation and prayer under the two lonely Saptaparni trees which were standing there. His love for this place of meditation transformed it into a place of beauty. Arrangements were made for bringing rich soil from outside, planting trees and shrubs and laying out a garden and orchard for the Asram. He named it 'Shantiniketan' (abode of peace) and dedicated it to the public as a place for meditation, free from all forms of sectarianism. Several years later, in December 1901, Rabindranath Tagore founded a Vidyalaya (school) at this place on

the lines of *Tapovana*, the ancient forest homes of India, where students led a communal life and lived and studied in harmony with nature.

In the summer of 1911 Mahalanobis spent two months at Shantiniketan in the company of Tagore. He was then a student of the Presidency College. Since then, he used to stay with Tagore whenever he went to Shantiniketan. In the same year, Tagore made an attempt to run the Adi Brahmo Samaj on the lines originally indicated by Rammohun Roy. He also revived the Tattva-bodhini Sabha (started by Devendranath Tagore in 1839) with a committee which included well-known and respected persons like Satyendranath Tagore (elder brother of Rabindranath), Shivnath Shastri (of the Sadharan Brahmo Samaj) and Benoyendranath Sen (of the Navavidhan Brahmo Samaj). Mahalanobis was made the Assistant Secretary.

On the eve of Tagore's departure for England in 1913 on his famous Gitanjali tour, the Asramika Sangha (an association of former students) was started with ten foundation members. The object of the Sangha was to secure the support of outsiders to the work of the Asram. Although Mahalanobis was not a former student of Shantiniketan, he was asked by Tagore to be a founder member of the Asramika Sangha.

Secretary of Visva-Bharati

In a special meeting of students, teachers and well-wishers of the Shantiniketan Asram which was held in the mango grove in Shantiniketan on 22 December 1918, Rabindranath Tagore explained his ideas about establishing an institution at Shantiniketan which would be a centre for the study of different eastern cultures. The name Visva-Bharati was adopted for the centre; Visva meaning the world in its universal aspects and Bharati having an allusion to wisdom, culture and the spirit of India (Bharat). The vedic text : 'yatra visvam bhavati ekanidam' (where the whole world forms its one single nest) was chosen as the motto of the centre. One of the main objects of Visva-Bharati was to seek to realize in a common fellowship of study the meeting of the East and the West, and thus to ultimately strengthen the fundamental conditions of world peace

through the establishment of free communication of ideas between the two hemispheres.

The Visva-Bharati was formally inaugurated as a public institution on 22 December 1921 with Rabindranath Tagore as Founder-President and his son Rathindranath Tagore and Prasanta Chandra Mahalanobis as its secretaries. Mahalanobis had a very big hand in drafting the first constitution of the Visva-Bharati which was not changed till the new constitution of the Visva-Bharati University was framed. He was its Secretary for about ten years and helped considerably in organizing its work and placing it on a firm foundation.

It may be mentioned here that Mahalanobis was at his side when Tagore wrote his historic letter to Lord Chelmsford in 1919 relinquishing his knighthood.

In a series of articles in Bengali written by Mahalanobis under the title 'Rabindra Parichaya' (Introduction to Rabindranath) and published in 1922 in the leading Bengali monthly magazine *Prabasi*, he made a detailed and interesting bibliographical study of Tagore's literary works. Mahalanobis's help, as an authority on Tagore's life and works, was sought by Edward Thomson when he wrote his monograph on Rabindranath Tagore. Edward Thomson acknowledged the help he had received from Mahalanobis in the preface to his book in the following words : "I owe a debt which I cannot exaggerate to Prof. Prasanta Mahalanobis; without his help I could have done nothing. That help has left its mark on every page."

Tours with Tagore

In 1926, Tagore received an invitation to visit Italy. He asked Mahalanobis and his wife to go with him and they agreed. On 16 May 1926, Mahalanobis and his wife left for Colombo and from there they sailed for Europe and reached Naples on 2 June 1926. They then joined Tagore and others at Rome and visited a number of places in Italy, Switzerland, Austria, France, Germany, Hungary, England, Norway and Sweden. They also got the opportunity to meet eminent personalities like Albert Einstein, Sigmund Freud and John Bojer. Later, Mahalanobis and his wife

went to London, where he worked in Karl Pearson's Laboratory in the University College, London, till the middle of 1927.

Mahalanobis, who realized the importance of Rabindranath Tagore's tour of Europe, used to write down the details of each day's events with the assistance of Rabindranath Tagore. He would then post weekly notes to India for publication in the Visva-Bharati bulletin. After some time, Rathindranath Tagore became indisposed to accompany them for a number of days. Prasanta Chandra and his wife had therefore to undertake this strenuous work of writing and sending the notes to India regularly. On their return to India, they learnt, much to their dismay, that the notes were lost. Several years later, Mahalanobis came to know from Rathindranath Tagore that the notes sent by him had been found under heaps of discarded old paper in a godown of the Visva-Bharati office. It remained a mystery as to why the notes were not published in the Visva-Bharati bulletin.

The notes were very valuable as they contained detailed accounts of Tagore's visits to different places in Europe, his meetings with important personalities including interviews with Mussolini and the King of Italy, and of the great affection and ovation he received from the people wherever he went. They also contained details of his discussions with Romain Rolland. While in Italy, Tagore had received a pressing invitation from Romain Rolland to visit Villeneuve in Switzerland where the latter resided. Tagore visited the place and stayed in Hotel Byron in the same room where Victor Hugo, the great French poet, had stayed years ago. Romain Rolland lived in an adjoining house, and he and Tagore met every day and had long discussions on a wide range of subjects such as music, art, literature and culture of Europe and the East, Mahatma Gandhi and the doctrine of non-violence, and fascism and post-war Italy.

In the summer of 1928, Tagore was to go abroad. Mahalanobis and his wife accompanied the poet up to Madras and from there in a French liner to Colombo. On the way, Tagore stopped at Pondicherry and on a special invitation from Sri Aurobindo, Rabindranath visited his ashram. Tagore's voyage to Europe had, however, to be cancelled as he fell quite ill in Colombo. During

this journey to the south, Tagore, accompanied by Mahalanobis and his wife and others, also visited Coonoor and Bangalore. The journey had a special significance because Tagore simultaneously started writing his two famous novels *Sheser Kabita* and *Jogajog* during this trip, although the characters and the themes of the two novels were quite different. The credit for inducing Tagore to write the novel *Sheser Kabita* goes to Mahalanobis and his wife. One evening while in Coonoor, it was raining outside they requested Tagore to tell them a story. Later, when Nirmal Kumari Mahalanobis insisted that he should continue the story, Tagore could not but yield. The novel was completed in Bangalore while Tagore stayed as a guest of Sir Brajendranath Seal. in Bangalore, Mahalanobis also took the opportunity to show Brajendranath Seal the results of the work on biometry which he had started in 1917 as a result of a discussion with Seal.

Very interesting details of their tours in Europe and in the south of India with Rabindranath Tagore are given in two valuable books in Bengali written by Nirmal Kumari Mahalanobis. She is also the author of another book in Bengali which depicts many interesting incidents in the life of Rabindranath Tagore from his childhood days as narrated to her by the poet himself on different occasions. The book also contains day-to-day accounts of the last days of Rabindranath Tagore from the beginning of July till his death on 7 August 1941. Nirmal Kumari Mahalanobis not only accompanied her husband on his tours to different parts of the world but had also the rare distinction of delivering lectures on Rabindranath Tagore in the USA, the USSR and Sweden.

Rabindranath Tagore had stayed with Prasanta Chandra and Nirmal Kumari on several occasions, first in the house at the Alipore Observatory and then in two other rented garden houses located in the northern outskirts of Calcutta not far from the present campus of the Indian Statistical Institute. Hence, when Nirmal Kumari went to Shantiniketan in early 1941, Tagore asked her whether there would be a room for him in their new house which was being constructed on the land which Prasanta Chandra had purchased. She replied in the affirmative, saying that when there could be a room for him even in their rented houses there would

certainly be a room for him in their own house. Tagore then enquired as to why she had not asked for a name for the new house, and she replied that she had thought of requesting him for a name after the construction of the house had progressed a little. He then asked her the name of the tree which was predominant in the garden and she replied that it was the mango tree. Tagore, very pleased to hear it, said that a beautiful and appropriate name for the house would be 'Amrapali', which was a classical name in Buddhist literature. Amrapali was the name of a garden belonging to a famous dancer who charged one thousand gold coins for a dance. When Buddha went to her garden one day to preach, she was converted as soon as she saw Buddha and heard his preaching. A new life dawned on her from that day and she gave away all her wealth to become a follower of Buddha and, since then, the Amrapali garden was considered a sanctuary. Rabindranath told Nirmal Kumari that he was giving a sacred name for their new house and she should see that nothing was done in the place to cause disrespect to this hallowed name. It was indeed a great disappointment to Mahalanobis and his wife that Tagore could not come and stay with them in their new house 'Amrapali' as he died before the house was completed.

CONTRIBUTIONS TO STATISTICS AND PLANNING

Statistics in the Early Days

THE USE OF statistics as a statecraft in Europe dates back to the time of Aristotle. He wrote a number of monographs giving details regarding science and arts, religious life, manners and customs, justice, public administration, etc., in 158 states. Statistics then meant a collection of facts which were of interest to a statesman. Up to the end of the eighteenth century, the statistics collected were very fragmentary owing to the difference of the public to cooperate with the government in the collection of the required information. This diffidence as well as the prejudice against the publication of statistical information disappeared in the nineteenth century, leading to a better and more comprehensive compilation of statistical data which were made accessible to the public.

As regards the analytic side of statistics there was a different story. Solution of problems which cropped up during games of chance (such as in throwing a dice or drawing a card) led mathematicians to give attention to the concept of probability. Although considerable progress had been made in the development of the theory of probability between the sixteenth and the nineteenth centuries through such famous mathematicians as Galileo, Pascal, Jacob Bernoulli, Abraham de Moivre and Laplace, the impact of the calculus of probability on statistics was not much. In the eighteenth century, however, mathematicians were intrigued by a problem in the theory of probability, viz. to find out the probable value of a single element which was measured a number of times with differing results. The problem was solved by Gauss and Laplace. The solution of the problem paved the way for the application of the calculus of probability in statistical investigations.

in the nineteenth century.* The modern era in the development of the theory of statistics may be said to have begun in the decade between the years 1893 and 1903 through the brilliant contributions of the famous Karl Pearson.

In India, statistics as a statecraft can claim a respectable antiquity. A detailed description of the procedures for conducting agricultural, economic and population censuses as well as a description of the industrial and commercial practices given in the *Arthashastra* of Kautilya (3rd century B.C.) proved the existence of a highly developed statistical system at about the time of Emperor Asoka. Another landmark in the growth of statistical systems in India was the period of Emperor Akbar. Details regarding area, revenue, strength of army, average yield of crops, wages, prices, etc., for about 15 provinces comprising over 130 districts and over 3000 townships and sub-divisions from Assam and Arakan to Afghanistan were given in *Ain-i-Akbari* (A.D. 1590) which contained the administrative report and statistical returns of Akbar's government.

In early nineteenth century a comprehensive statistical survey of the territories under the government of Bengal Presidency was undertaken for seven years by Dr. Francis Buchanan under orders of the East India company. A report on the survey was published in 1838 by Montgomery Martin, London. Although it was conducted over a small area, the wealth and reliability of the information collected made the survey one of the most outstanding ones for all times.

In 1862, a committee was set up by the Government of India for the preparation of standard statistical forms for a uniform system of compilation of statistics on trade, education, population, agriculture, finance, etc. The collection of statistical information on these forms led to the publication of the *Statistical Abstract of British India*, first in 1868 and then continued for several years. The *Statistical Abstract* contained a lot of useful information about all the provinces of British India. Since then, the Government tried to strengthen its statistical machinery by

*Westergaard, H.: *Contributions to the History of Statistics*. P.S. King & Son Ltd., London, 1932; Mouton Hague & S.R. Publishers, Wakefield, 1969.

in Calcutta. After omitting certain incomplete and doubtful records he had selected the measurements of 200 individuals, which he thought, represented a true Indo-European mixture and gave the data to Mahalanobis for statistical analysis. This was the first time that data relating to a true biologically mixed population were studied by statistical methods. Out of these measurements, Mahalanobis selected stature for a detailed statistical analysis and his first paper on statistics was "The Statistical Analysis of Anglo-Indian Stature" which was published in the Records of the Indian Museum in 1922.

Mahalanobis continued the statistical analysis of these anthropological measurements and the subject of his Presidential Address at the session of the Anthropological Section of the Indian Science Congress in Banaras in 1925 was "Analysis of Race Mixture in Bengal". In this, the main question for study was whether the Anglo-Indians had any affinity towards the other communities, castes or tribes within or outside Bengal and the extent of such affinity. The Presidential Address was published in the *Journal of the Asiatic Society of Bengal*. This statistical analysis was important for the fact that Mahalanobis made use of the D^2 -statistic for the first time, though in a somewhat crude form. The D^2 -statistic (known as Mahalanobis generalized distance) was one of the main contributions of Mahalanobis to statistical methods and was used to measure the extent of divergence or affinity between groups. In anthropology, biometry, demography, econometrics, geology, psychology, etc., it is often necessary to find out the inter-relationship between one or more groups and not between individuals in a group. In such cases, the D^2 -statistics is a very useful tool for measuring the extent of such inter-relationship.

At about the time Mahalanobis was engaged in his statistical analysis of the anthropological measurements received from Annandale, Karl Pearson had devised the Coefficient of Racial Likeness for comparing resemblance of racial groups. This coefficient, which was first used in 1921, was actually a test of divergence and not a measure of the extent of group divergence as D^2 -statistic was. The D^2 -stastistic was thus, in a way, a better tool in taxonomical investigations.

Another important contribution of Mahalanobis to the statistical analysis of anthropological measurements was his revision of Risley's anthropometric data. Between 1886 and 1888, Sir Herbert H. Risley, a member of the Indian Civil Service, who held important positions under the Government of Bengal and the Government of India, had collected numerous anthropological measurements of different tribes and castes of Bengal as well as of the hill tribes of Chittagong. His findings were published in his book *The Tribes and Castes of Bengal*, published in 1891. Although widely mentioned in references, a good deal of acrimonious controversy took place with regard to Risley's anthropometric data. A decade after the publication of Risley's book, Karl Pearson found serious discrepancies in the figures given in the book. Mahalanobis, therefore, made a very careful and detailed scrutiny and analysis of the data to answer Pearson's criticism. In two very important papers written by Mahalanobis on Risley's anthropometric data, he showed that the real defect in the data had crept in during the calculation of the average values and the discrepancies in individual measurements and indices could be corrected with certainty. He also concluded that Risley's primary data were singularly free from mistakes and could be used with the corrections given in Mahalanobis's paper.

According to convention, Mahalanobis's first paper "The Statistical Analysis of Anglo-Indian Stature" was referred to Sir Gilbert Walker (then Director General of Observatories) for his opinion and he asked Mahalanobis to undertake a statistical study of some meteorological problems. During the study, Mahalanobis found by purely statistical methods that the region of highest control for changes in meteorological conditions on the surface of the earth was located at a height of about four kilometers above the sea-level. This fact was rediscovered from physical considerations several years later by F. Bauer in Germany. After these meteorological studies, Mahalanobis was appointed meteorologist in the Alipore Observatory in Calcutta.

Incidentally it may be mentioned that Sir Gilbert Walker had once been a guest of Mahalanobis in his Alipore Observatory residence when Rabindranath Tagore was also staying there. That

was about two months before Mahalanobis got married. After Mahalanobis's marriage, when Rabindranath Tagore came to stay in that house again, he jokingly told Nirmal Kumari about the great difficulty which Mahalanobis had to face on the previous occasion while trying to entertain two important guests in the house without a housewife.

Two disastrous floods occurred, one in 1922 in North Bengal and the other in 1926 in Orissa and after each of these floods the question of flood control was referred to Mahalanobis. This led him to undertake extensive and laborious statistical studies of rainfall and floods in Bengal and Orissa covering about sixty years. The studies supplied some of the basic calculations which were later used for the two hydro-electric and irrigation projects in the Damodar Valley and Hirakud.

Mahalanobis had, for many years, engaged one or two computing assistants who helped in computational work at his home, but on his return from abroad in 1927, this arrangement was no longer possible as there was a change of his residence. It was, therefore, necessary to make some alternate arrangement. In 1928, the Government of Bihar and Orissa asked Mahalanobis to prepare the Report on Rainfall and Floods in Orissa. This necessitated the appointment of three more persons to do computational work. Arrangement was made for these additional hands to sit in a room adjoining Mahalanobis's room in the Physics Department of the Presidency College, partitioned by two or three almirahs. On the other side of the partition, Subhendu Sekhar Bose, a pupil of Mahalanobis and a brilliant student of physics, was carrying on research in physics. After great persuasion by Mahalanobis, Bose agreed to shift his interest from physics to statistics and soon became an equally brilliant research worker in statistics.

In 1924, Mahalanobis wrote a paper on the probable error of the results of agricultural experiments without knowing about the work done a little earlier by Ronald Aylmer Fisher at the Rothamsted Agricultural Station in England. Dr. (later Sir) Ronald Aylmer Fisher rose to a great eminence for his original and outstanding contributions in both theoretical and applied statistics. His first paper on agricultural field trials, published in 1923,

revolutionized the technique of agricultural experiments throughout the world and laid the foundation of later work on the design of experiments. When Fisher came to know about Mahalanobis's paper, he sent his own papers on the subject to the latter. During his visit to England in 1927, Mahalanobis met Fisher at Rothamsted which led to a very close association between the two for over three decades. It was due to Mahalanobis that statistical methods on Fisherian lines were introduced in India for the first time.

On the recommendation of the Royal Commission on Agriculture, the Imperial (now Indian) Council of Agricultural Research (ICAR) was established by the Government of India in 1929 after consultation with the Rothamsted Agricultural Station. Fisher had apparently suggested the name of Mahalanobis as the likely person who could help the ICAR as a consultant for their statistical work. In 1930, Mr (later Sir) Bryce Bartt (then Agricultural Expert and later Vice-Chairman of ICAR) and Dr. N. Gangulee (who was on the Royal Commission and at that time a member of ICAR) came to see Mahalanobis and suggested that he could ask for a small research grant for statistical studies relating to agriculture.

Subsequently, in July 1931, the first grant of Rs. 2500 a year was sanctioned by ICAR for three years. This grant enabled Mahalanobis to appoint two or three persons on a full-time basis. In 1931, the entire staff of the Statistical Laboratory comprised Subhendu Sekhar Bose as the scientific assistant, Sudhir Kumar Banerjee (who started work in 1924 in connection with the North Bengal Flood Report) as the trained computing assistant and two other assistants who were not trained. Subhendu Sekhar Bose bore the brunt of the research and training work till his death in 1938 at the young age of 32 years. His death was an irreparable loss.

An interesting event may be mentioned here. During a summer vacation in the early nineteen-thirties, Mahalanobis had gone to Darjeeling. There he happened to meet the Director of Public Instruction, Government of Bengal, who told him that the Education Department was contemplating to send him outside Calcutta as principal of a college. Greatly dismayed to learn about this, Mahalanobis conveyed to the Director that he would prefer to stay in Calcutta even if that meant loss of promotion. Similar proposals

which had been made earlier had not taken effect due to Mahalanobis's reluctance to leave Calcutta and interrupt his scientific work. Thus he was greatly surprised on his return to Calcutta, to receive an order of his transfer promoting him to the post of principal of a college outside Calcutta. Rabindranath Tagore was then staying with Mahalanobis and his wife in a garden house in Baranagar in the northern outskirts of Calcutta. Mahalanobis narrated the whole story to Tagore and mentioned his intention to resign from government service rather than discontinue his scientific work. Tagore, who used to take a keen interest in the statistical work of Mahalanobis, had visited the Statistical Laboratory in the Presidency College on many occasions. He was informed that Mahalanobis and the workers of the Statistical Laboratory had a good knowledge of agricultural experiments and the use of fertilizers for increasing the yields of crops and that they could perhaps rent a large garden house and start horticulture to grow vegetables and flowers for the Calcutta market. The poet strongly supported Mahalanobis's idea of resigning from government service and taking up horticulture. He even accompanied Mahalanobis and his wife to some of the garden houses in and around Baranagar to find a suitable place for this enterprise. Tagore's interest and encouragement gave Mahalanobis great moral support. Subhendu Sekhar Bose and Sudhir Kumar Banerjee also agreed that Mahalanobis should resign from government service, if necessary, to continue the statistical studies. They were confident that they would be able to earn a living. Mahalanobis and Bose could perhaps take up some coaching work in physics, mathematics and chemistry for the examinations of the Calcutta University and also hold tutorial classes. Ultimately, however, the Government reversed its decision to transfer Mahalanobis. He was superseded two or three times by junior colleagues and his promotion to the selection grade was delayed, but he considered that to be a small price to pay for the privilege of staying in Calcutta and continuing his scientific work. Tagore was naturally very pleased that everything ended well.

It was the enthusiasm of Subhendu Sekhar Bose and Harish Chandra Sinha that gave Mahalanobis the courage to canvass the idea of starting the Indian Statistical Institute. Harish Chandra

Sinha was a brilliant mathematician who later got his doctorate in economics. As the first joint Secretary of the Institute, he rendered invaluable service by contacting a number of statisticians and statistical institutions during his extensive tour in Europe in 1934 to make the work of the Indian Statistical Institute known abroad. The Indian Statistical Institute was established on 17 December 1931 with Sir R.N. Mookerjee, the eminent industrialist, as the first President and P.C. Mahalanobis as the Honorary Secretary.

Mahalanobis had a special ability for locating talents and was seldom wrong in his selection. Apart from Subhendu Sekhar Bose he also discovered two outstanding mathematicians—Raj Chandra Bose and Samarendra Nath Roy. Raj Chandra Bose was a lecturer of mathematics in the Ashutosh College, Calcutta. Mahalanobis was on the look-out for a mathematician with knowledge of n-dimensional geometry and Raj Chandra Bose was recommended by his teacher, Professor Shyamadas Mukhopadhyaya. One morning in December 1932, Mahalanobis went to Bose's residence and requested him to join the Indian Statistical Institute. Bose was slightly apprehensive as he had very little knowledge of statistics but Mahalanobis assured him that he would learn it. Raj Chandra Bose not only learned statistics at the Institute, but went a step further by earning international fame for himself and the Institute by his outstanding contributions to the subject. As for Samarendra Nath Roy, he was doing research work in the University of Calcutta when he was persuaded by Mahalanobis to join the Institute in 1935. Initially both R.C. Bose and S.N. Roy were engaged in research work related to Mahalanobis's D^2 -statistic which led Roy to make very important contributions in multivariate analysis. Bose's interest, however, shifted to design of experiments after R.A. Fisher, during his visit to the Indian Statistical Institute in 1938, told him about some unsolved problems in the field. This was the beginning of the research work in design of experiments in the Institute under the leadership of R.C. Bose. In 1949 R.C. Bose joined the University of North Carolina as Professor of Statistics and S.N. Roy joined the same university in 1950. Both of them settled in the USA.

Contributions to Sampling Methods

The next major contribution of Mahalanobis was in the field of large-scale sample surveys. The Indian Central Jute Committee, set up by Government, had undertaken an exploratory sample survey of the jute crop in Bengal in 1937 under the technical guidance of Mahalanobis. Sample surveys were unknown at that time and government officials had no idea of sampling methods. In fact, it is said that the minister in charge of the project could not understand as to how any reliable estimate of the total yield of the jute crop could be made by just taking samples from a relatively small area and without surveying the entire area, and sampling was almost on the point of being abandoned altogether.

At this juncture, Fisher was invited to come to India to preside over the first Indian Statistical Conference held in Calcutta in January 1938. As the Indian Science Congress did not favour the idea of starting a section for statistics, the Indian Statistical Institute decided to hold statistical conferences independently every year at the time of the Indian Science Congress Sessions. These conferences had great promotional value and the Indian Science Congress Association ultimately agreed to have a section for mathematics and statistics in 1942 with Mahalanobis as the Sectional President. It also agreed to start a separate section for statistics from 1945 onwards.

In his presidential address delivered at the first session of the Statistical Conference and in a memorandum submitted to the Government in 1938, Fisher strongly supported the development of sampling methods in India. He also stressed the organizing of statistical studies and expressed the opinion that the obvious place for development of sampling techniques and the organization of statistical training was the Indian Statistical Institute which had facilities for both.

A little earlier, on 15 December 1937, His Excellency, Marquess of Linlithgow, Viceroy and Governor General of India, had visited the Indian Statistical Institute. Fisher had also talked to the Viceroy and the Governor of Bengal and other government officials.

All these events had the effect of inducing the Indian Central Jute Committee and the Government of Bengal to decide to pro-

ceed with the sample survey of the jute crop on a larger scale. A large-scale sample survey of the area under jute for the whole of the province of Bengal was thus undertaken in 1940, the report of which was later published in 1968 as a book under the title *Sample Census of Area under Jute in Bengal, 1940*. Mahalanobis had since written several reports for the Indian Central Jute Committee. In this way, sample surveys of agricultural crops and later large-scale economic and social surveys became a very important activity of the Indian Statistical Institute, leading to the inauguration, in 1950, of the National Sample Survey, reputed to be the largest sample survey of its kind in the world.

Professor Harold Hotelling, Professor of Statistics, Columbia University, USA, who came to the Indian Statistical Institute in 1939-40, wrote in his report to the Central Jute Committee that no technique of random samples had so far, as he could find, been developed in the United States or elsewhere, which could compare in accuracy or in economy with that described by Professor Mahalanobis.

The two-stage sampling procedure suggested by Mahalanobis in his book *Sample Census of Area under Jute in Bengal, 1940*, may, in a way, be regarded as a forerunner of sequential analysis in which the number of observations is not fixed in advance but is dependent on the results of the observations as they are made.

Three main contributions of Mahalanobis to sampling methods were : (1) pilot surveys, (2) inter-penetrating network of sub-samples (IPNS), and (3) the concept of optimum design of surveys. A pilot survey was usually undertaken to collect information on cost and precision before undertaking a large-scale survey. The use of IPNS was a very useful method of controlling and estimating the errors particularly due to investigators. The procedure was to get the information collected independently by two different investigators, which supplied two independent estimates from which it was possible to assess whether the data were collected with care and honesty. The concept of optimum design was to adopt a sampling method by which it was possible either to minimize the cost for a desired level of precision or to maximise the precision for a given level of cost. The logical foundations

of the technique of large-scale sample surveys were described by Mahalanobis in his memoir on the subject which was published in the *Philosophical Transactions of the Royal Society*, London, in 1944. He also wrote a book entitled, *Experiments in Statistical Sampling in the Indian Statistical Institute* which was published in 1961. Mahalanobis received the Weldon Memorial Medal and prize from Oxford University in 1944 and was elected a Fellow of the Royal Society, London, in 1945 for his fundamental contributions to statistics and particularly in the field of large-scale sample surveys.

Sankhyā : The Indian Journal of Statistics

The need for starting a journal for stimulating research and advanced studies in statistics in India was felt since the establishment of the Indian Statistical Institute in 1931. In fact, at the first meeting of the Institute held on 17 December 1931, a resolution was adopted to appoint a Journal Committee to report on the possibilities of starting a statistical journal. The Institute was, however, not in a position to take charge of the finances nor shoulder the responsibility of publication and management of the journal.

After a few months' search, Mahalanobis succeeded in persuading Narendra Nath Mookerjee, proprietor of the Art Press, one of the top printing presses of Calcutta at that time, to undertake the responsibility of printing, publishing and business management of the journal. Mahalanobis had however to agree to give a guarantee, in his personal capacity, to make good any loss which might be sustained by the Art Press. The first issue of the journal was brought out in June 1933, with Mahalanobis as its Founder-Editor.

It was decided that the name of the journal should be *Sankhyā*. In the editorial published in the first issue of the journal, Mahalanobis explained the reason for selecting the name '*Sankhyā*' an extract of which is given below :

"We believe that the idea underlying this integral concept of statistics finds adequate expression in the ancient Indian word *sankhyā*. In Sanskrit the usual meaning is 'number', but the original root meaning was 'determinate knowledge'. In the

Atharva-Veda a derivative form *sankhyata* occurs both in the sense of 'well-known' as well as 'numbered'. The lexicons give both meanings. *Amara-kosa* gives *sankhya* as *vicarana* (deliberation, analysis) as well as 'number'; also *sankhyavan* as *panditah* (wise, learned).

"The same dual sense is attached to its derivative from *Sankhyā* which is the name of the most famous analytic philosophy of ancient India. The name of the philosophical system is explained in both ways : as a philosophy based essentially on enumeration of the categories beginning with Nature or Root Cause. Or else a philosophy by which is revealed the adequate knowledge of reality. The root meaning is also met with in the Mahabharata in the Gita portion where the *Sankhyā* system of philosophy is classified with the Vedanta as being based on *jnana* (or intellectual cognition) as distinguished from the yoga systems. Sridhara, in his commentary on the Gita, explains *Sankhyā* as *samyag-jnana*, that is, 'proper cognition' or 'adequate knowledge'.

"The history of the word *Sankhyā* shows the intimate connexion which has existed for more than 3000 years in the Indian mind between 'adequate knowledge' and 'number'. As we interpret it, the fundamental aim of statistics is to give determinate and adequate knowledge of reality with the help of numbers and numerical analysis. The ancient Indian word *Sankhya* embodies the same idea, and this is why we have chosen this name for the Indian Journal of Statistics".

The arrangement with the Art Press continued for about two years, but when the press found that there was no possibility of the journal becoming remunerative, it wanted to terminate the agreement. The proprietor, however, agreed to give certain facilities in his press for composing the articles received for *Sankhyā* and Mahalanobis employed a compositor for this purpose and paid the salary out of his own pocket.

When the arrangement with the Art Press had to be terminated and Mahalanobis was not in a position to continue to bear the business and managerial responsibilities on his own, it was decided by the Indian Statistical Institute that a separate organization be started for publishing *Sankhyā*.

Thus the Statistical Publishing Society was established in 1935 as an associated organization of the Indian Statistical Institute. It took over from Mahalanobis the entire responsibility of printing, publication and business management of *Sankhyā*: but he gave a personal guarantee to meet the whole of the deficit which might be incurred by the society on account of the journal. As a large number of mathematical signs and special symbols, which were not available in India, were required for printing *Sankhyā*, Mahalanobis had a small hand-operated type-casting equipment imported from England at his own expense. Later, the Statistical Publishing Society purchased one small power-driven treadle printing machine and set up the Eka Press in 1938.

In 1940, a monotype machine for composing mathematical matter was purchased at a cost of over Rs 26,000 with the help of special grants from the Government of India and the Government of Bengal, together with an advance made by Mahalanobis himself. Mahalanobis also acted as a guarantor, in his personal capacity, when a loan had to be procured from a bank, on the security of the monotype machine, for providing working capital to the Statistical Publishing Society.

While on the subject of Mahalanobis's contributions to the publication of statistical literature in India by the establishment of the Statistical Publishing Society and the Eka Press, mention may be made here of an important printing and publishing project initiated by him three decades later. In October 1967, a tripartite agreement was made in Moscow between the Academy of Sciences of the USSR, the Indian Statistical Institute, and the Statistical Publishing Society. The agreement was signed by Mahalanobis on behalf of the Indian Statistical Institute as its Honorary Secretary and the Statistical Publishing Society as its President. This agreement resulted in the Soviet Academy of Sciences making a gift of a large quantity of printing machinery to the Indian Statistical Institute. The equipment were to be used for printing and publishing in India, English translations of Russian scientific publications. The remaining capacity was to be used for publishing books for the advancement of science and learning in general. The management of the printing and publishing project was given to

the Statistical Publishing Society which set up another printing press, named Troika Press, for the use of the Soviet printing machinery.

As stated above, the first number of *Sankhyā : The Indian Journal of Statistics* was out in June 1933, and since 1935 it was published by the Statistical Publishing Society as the official organ of the Indian Statistical Institute. For a long time *Sankhyā* has been recognized as one of the leading journals in the world on statistics and allied subjects. Papers are received for publication in the journal from eminent authors from different parts of the world.

The following lines received from Rabindranath Tagore were published in the second number of *Sankhyā* in 1935 :

"The enchantment of rhythm is obviously felt in music, the rhythm which is inherent in the notes and their grouping. It is the magic of mathematics, this rhythm which is in the heart of all creation, which moves in the atom and in its different measures fashions gold and lead, the rose and the thorn, the sun and the planets, the variety and vicissitudes of man's history. These are the dance-steps of numbers in the arena of time and space, which weave the maya of appearance, the incessant flow of changes that ever is and is not. What we know as intellectual truth, is that also not a perfect rhythm of the relationship of facts that produce a sense of convincingness to a person who somehow feels that he knows the truth ? We believe any fact to be true because of a harmony, a rhythm in reason, the process of which is analysable by the logic of mathematics."

Training Courses in Statistics

From 1932, the Indian Statistical Institute started short training courses in statistics which were attended by officers on deputation from the Government and other organizations from all over India. These were the only training courses available till the Post-Graduate Department of Statistics, the first of its kind in India, was established by the University of Calcutta in 1941, with Mahalanobis as its Honorary Head. The founding of the department was on the basis of a note submitted by Mahalanobis with the active support

of Dr. Shyama Prasad Mookerjee, then President of the Councils of Post-Graduate Teaching in Arts and Science. Topping the list of candidates who passed the first examination for the master's degree in statistics, held by the University in 1943, was C.R. Rao.

C.R. Rao was a pupil of Mahalanobis and later his close associate in the Indian Statistical Institute for many years. He became interested in statistics by chance. After obtaining a master's degree in mathematics with a first class and first rank from the University of Andhra in 1940, he became to Calcutta with the object of joining the Army. There he came in contact with a research scholar of the Indian Statistical Institute and visited the Institute with him. Impressed by the work done there, he decided to join the one-year course of training in statistics conducted by the Institute. Rao was among the first batch of students who joined the post-graduate department of statistics of the Calcutta University when it was opened in 1941. He showed great promise in physics and mathematics in his early career but after he shifted his interest to statistics, his brilliance in statistics brought him top awards and honours and also international recognition quite early in life. He received the Shanti Swarup Bhatnagar Award of the Council of Scientific and Industrial Research in 1963 for his contributions to scientific research and the Guy Medal of the Royal Statistical Society, London, in 1965. In 1967, he was elected a Fellow of the Royal Society, London, at the age of forty-seven for his contributions to statistical theory, multivariate analysis and biometric method. Rao received the Padma Bhushan Award in 1968 for services to the country in the sphere of statistical education and research. He travelled extensively on lecture tours abroad and attended several international conferences. The laurels won by C.R. Rao brought honour not only to himself but also to Mahalanobis and the Indian Statistical Institute.

In 1946, Mahalanobis was appointed a member of the Statistical Commission of the United Nations Organization, and in April of the same year, he went to the USA to attend the first session of the Commission. He was accompanied by his wife and, as no seats were available on commercial flights, they had the special privilege of travelling in a U.S. air force plane which was returning to the

USA with airmen. This was the first visit that Mahalanobis and his wife made to the USA, and their first trip abroad since they went to Europe and the UK in 1926-27. It was also the beginning of about seventy foreign tours undertaken during the next twenty-five years, in the course of which Mahalanobis visited Australia, Austria, Belgium, Brazil, Bulgaria, Burma, Canada, China, Czechoslovakia, Denmark, Egypt, France, Germany, Greece, Hungary, Italy, Japan, Netherlands, Norway, Pakistan, Poland, Puerto Rico, Rumania, Spain, Sweden, Switzerland, Thailand, Turkey, UK, USA, USSR and Yugoslavia. A fuller account of his tours abroad will be given later.

During his first visit to the USA, Mahalanobis met Dr. Walter A Shewhart, who was known as the 'father of Statistical Quality Control'. The meeting took place at a dinner in the Columbia University in October 1946 on the occasion of the farewell to Professor Harold Hotelling. As mentioned earlier, Professor Hotelling had come to the Indian Statistical Institute as a visiting scientist in 1939-40, and helped to establish contacts between the statisticians of the Institute and those of the USA for the first time. In December 1946, Shewhart took Mahalanobis to the Bell Telephone Laboratories (the research wing of the Bell Telephone System), USA, where he had introduced the technique of statistical quality control in 1924. On this occasion, he also invited Mahalanobis and his wife to stay in his home overnight. This was the beginning of a very close friendship of many years.

Mahalanobis first came to know about Shewhart's lectures on quality control delivered in London in 1931 from a note published in the journal *Nature*. He had immediately procured a copy of Shewhart's classical book *Economic Control of Quality of Manufactured Products* from the USA, and was so impressed by the book that he had sent a note to Sir Frank Noyce, then a member of the Viceroy's Executive Council, in 1935 on the need of using statistical quality control and associated methods in India. He again wrote to the Government of India in 1942 pointing out the advantages of using statistical quality control methods particularly in industries which were then engaged in manufacturing products according to military standards. Nothing, however, happened till

Professor A.V. Hill, then Secretary of the Royal Society, London, came to India in 1944 to advise on the organization of scientific research. On his recommendation, the Council of Scientific and Industrial Research appointed a committee on statistics, standards and quality control with Mahalanobis as its Chairman. During 1945-46, a special training course in statistical quality control, the first of its kind in India, was arranged in the Indian Statistical Institute.

Shewhart's technique of statistical quality control in industry may be said to be as great a contribution to statistics as a key technology, as Fisher's method of design of experiments in agriculture. Their discussions in 1946 made Mahalanobis foresee the tremendous possibilities of the use of statistical quality control methods in industry, and it was at his instance that Shewhart was invited to visit India in December 1947. The visit created widespread interest among industrialists, and a conference on standardization and quality control was held in Calcutta on the occasion, in February 1948. Besides delivering his presidential address at the conference, Shewhart also gave lectures on some fundamental concepts of quality control and the use of statistical quality control in research and development, design and specification, and in production and inspection. Shewhart visited the Indian Statistical Institute four or five times and donated to the Institute his entire collection of very valuable books in his personal library. His visit to India was followed by visits of a number of other experts in quality control from the USA, the UK and Japan. As a consequence the Indian Statistical Institute took initiative in spreading the use of quality control methods in industry by establishing statistical quality control units in different parts of India since 1953.

Sir Ronald Aylmer Fisher's support to Mahalanobis during the formative years of the Indian Statistical Institute and also later, during his seven visits to the Institute, had helped to lay a strong foundation on the scientific side. Apart from that, Mahalanobis also received great encouragement and support from Jawaharlal Nehru and Chintaman Dwarkanath Desmukh, particularly during the periods of great uncertainty from the year 1945 onward.

Studies in Planning for National Development

Mahalanobis had met Jawaharlal Nehru a number of times before 1940 when the latter came to see Rabindranath Tagore. It was only in 1940, however, that he had the opportunity of spending a day with Nehru in the latter's house in Allahabad and having discussions about the importance and need for planning and the role of statistics in planning. The National Planning Committee had been set up by the Congress President in October 1938 with Jawaharlal Nehru as Chairman. After the discussions with Mahalanobis in Allahabad, Nehru raised the question of statistics at the third session of the National Planning Committee held in May 1940. Mahalanobis was asked to write a statistical supplement to the report by the Committee.

Nehru came to Calcutta in March 1946 for a week's stay. He was to preside over the session of the Indian Science Congress of which Mahalanobis was then the Secretary, be the Chief Guest at Convocation of the Calcutta University, and then conduct his election campaign in different places. He mentioned to Mahalanobis his tight schedule in Calcutta and said that they would get hardly any time to talk. But he made a suggestion that if he could stay with Mahalanobis, they could have some discussions. Prasanta Chandra was delighted to hear this and immediately made arrangements for Nehru to stay in Amrapali. Soon after Nehru's arrival in his house, Mahalanobis took him round the Indian Statistical Institute and explained to him the Institute's work in detail. He stressed the magnitude and the importance of the work done there, and the indispensability of statistics in planning any future programme of development in the country. Mahalanobis also told Nehru that it should be possible to select at least four bright young men from the Congress party and send them to the Institute for training in statistics.

In April 1946, Nehru sent his secretary Pitamber Pant to Mahalanobis. Pant had studied physics in the University of Allahabad and later worked as a lecturer under the eminent scientist Meghnad Saha. Inspired by Jawaharlal Nehru, he had taken an active part in politics since 1942 and became Nehru's secretary. When Mahalanobis went to the USA in October 1946, Pitamber Pant

accompanied him as his scientific secretary on a grant from the Ministry of Education, Government of India. Since then, he was a very close associate of Mahalanobis for over twenty-five years. He helped considerably in the development of the Indian Statistical Institute and particularly in the studies in planning undertaken by the Institute in collaboration with the Government of India. He was chief of the Perspective Planning Division of the Planning Commission and later became a member of the Planning Commission. He was also Vice-President of the Indian Statistical Institute from 1967 to 1972.

The work on planning could not make much headway till India attained independence in August 1947 with Jawaharlal Nehru as Prime Minister. The All-India Congress Committee appointed an Economic Programme Committee in November 1947 with Nehru as chairman. In its report submitted in January 1948, the committee recommended, *inter-alia*, the appointment of a permanent Planning Commission, which was subsequently set up in 1950 with Nehru as chairman. The First Five-Year Plan of India (1951-52 to 1955-56) was formulated soon after. The main emphasis in this Plan was on agriculture and not on the development of basic industries or on the production of steel. The shortage of steel became so acute that the Prime Minister was convinced about the immediate need for increasing its production.

In the meantime, Mahalanobis was appointed Honorary Statistical Adviser to the Cabinet, Government of India, Chairman of the Committee of Central Statisticians, and Chairman of the National Income Committee in 1949. C.D. Desmukh had been appointed Financial Adviser to the Government of India in 1949. Nehru had discussions with both Desmukh and Mahalanobis about starting a continuing sample survey for the whole of India, and the National Income Committee also emphasized the need for such a survey. On the desire of the Prime Minister, the National Sample Survey was established in 1950 for collecting information on social, economic and demographic conditions for the entire country from year to year. The National Sample Survey, in which the work of design, processing and analysis of data was done in the Indian Statistical Institute, was, as stated earlier, the largest of its kind in the world.

The appointment of Mahalanobis as Honorary Statistical Adviser necessitated the setting up of a Central Statistical Unit in the Cabinet Secretariat and a small office of the Indian Statistical Institute in New Delhi. Pitamber Pant and the Institute staff helped in running the Central Statistical Unit for nearly two years until the Central Statistical Organization was established in 1951 for co-ordinating the activities of the statistical agencies in the Central Government and the activities of the State Statistical Bureaus which were set up in all the States.

Mahalanobis was the architect of the Second Five-Year Plan. In September 1954, the Planning Commission, after a good deal of deliberations, decided that planning should have a longer perspective of fifteen to twenty years or more, and that the basic aims of planning should be to increase the level of national income and the level of living, to solve the problem of unemployment, to bring about equality of opportunities and to remove disparities of income and wealth. With these ends in view, the Planning Commission asked the Indian Statistical Institute to undertake studies in planning jointly with the Economics Division of the Planning Commission, the Department of Economic Affairs of the Ministry of Finance and the Central Statistical Organization of the Cabinet Secretariat. The joint studies relating to planning for national development were inaugurated by Jawaharlal Nehru in the Indian Statistical Institute in November 1954. On the basis of these studies, Mahalanobis prepared a Draft Plan-frame which was submitted to the Government in March 1955. This Draft was accepted as the basis for the formulation of the Second Five-Year Plan which had a new approach. The principal objective of the Second Five-Year Plan were an increase in national income of about five per cent per year and creation of employment opportunities for ten to twelve million persons during the plan period. Unlike the First Five-Year Plan, where the emphasis was more on the development of agriculture, Mahalanobis suggested that emphasis should be laid in the Second Plan on the rapid development of basic heavy industries in the public sector for the production of steel and non ferrous metals, heavy chemicals, heavy machinery, fertilizers, etc., and also on the production of consumer goods, as

far as possible, through labour-intensive household and small-scale industries which would generate employment. The outlay on the Second Five-Year Plan in the public sector was about Rs. 4,500 crores in five years, that is, about double the outlay on the First Five-Year Plan.

In September 1955, the Government of India decided that studies of planning should continue in the Indian Statistical Institute with greater attention to perspective planning, and planning units were set up in the Institute both in Calcutta and Delhi. Mahalanobis invited to the Institute a number of eminent economists from different parts of the world to help in these studies.

The utility of adopting the investment policy advocated by him for the Second Five-Year Plan was demonstrated by Mahalanobis by the means of his two-sector and four-sector mathematical models of planning. In the two-sector model, the net output of the economy was considered to originated in the two sectors, one producing the investment goods, such as in the key heavy industries and the other, producing all consumer goods. In the four-sector model, the consumer goods sector was further subdivided into large-scale industries of the factory type, small-scale industries including agriculture, and services of all types. Mahalanobis was not an economist nor did he try to apply the well-tested tools of economists for finding out optimum solutions of problems. He was aware of the many problems facing the country even at the end of the First Plan period. The population was increasing at a rate of four and a half millions every year, there was a great deal of unemployment and underemployment and new jobs were to be provided annually for nearly two million persons, the level of living was very low; and it was necessary not only to provide jobs but also to provide better housing and health services and opportunities for education, particularly for the poorer sections of the people. Mahalanobis saw the need for adopting a bold and scientific approach to planning in order to solve these problems in the quickest possible time.

Mahalanobis's approach to planning has been criticized for certain inadequacies but it is to be remembered that he did not claim that, by his approach, he was making any new contribution

to economic theory or was providing the best solution to the problems. His model of planning served mainly as an aid to understanding the broad characteristics of the economic system in the absence of past experience in planning. In fact, he was of the opinion that a model was only a scaffolding to be dismantled once the building was erected. Mahalanobis deserves credit for initiating a new line of thinking with regard to planning in India at a time when the Government was yet to be fully geared to meet the basic requirements of the country and its people.

During the six or seven years following the submission of the Draft Plan-frame for the Second Five-Year Plan, Mahalanobis had written and given lectures and addresses and also spoken on the radio on various aspects of planning such as national income, investment and national development, science and national planning; industrialization of underdeveloped countries; the need for scientific and technical man power; unemployment; and labour problems in a mixed economy. All these contributions were compiled and published in 1961 in his book *Talks on Planning*. The logical and factual bases of the recommendations for the formulation of the Second Five-Year Plan were explained in his book *The Approach of Operational Research to Planning in India* (1963). He was a member of the Planning Commission from 1955 to 1967.

Growth of the Indian Statistical Institute

The Indian Statistical Institute had to pass through a period of great uncertainty between 1945 and 1950 when the political and economic conditions in the country were in a state of flux. Mahalanobis started going abroad from 1946 in connection with his work at the U.N. and other places. C.R. Rao accepted a research post in the University of Cambridge in 1946 and R.C. Bose and S.N. Roy accepted posts in the USA in 1949 and 1950 respectively. At this critical juncture in the history of the Institute, C.D. Desmukh was elected its President in 1945 and the eminent scientist Professor Satyendranath Bose very kindly agreed to undertake the responsibility of looking after the administrative work as Secretary when Mahalanobis was abroad between 1946 and 1948.

Bose was a close friend of Mahalanobis since the very early days of their careers and had taken great interest in the Indian Statistical Institute almost from its inception. He was President of the Institute from 1967 till his death in February 1974.

As stated earlier, C.D. Desmukh first met Mahalanobis in 1920 and stayed with him as his guest for some time in Calcutta. There was, however, no contact between them for a number of years, till, in 1939, Desmukh became the Secretary of the Education, Health and Lands Department of the Government of India. They met in Simla where Mahalanobis had gone to plead for a small sum not exceeding four digits, as support to the Indian Statistical Institute from the Government of India. After reading an account of the random sampling experiments of John Hubback, about which mention has been made before, Deshmukh had himself applied the technique for about three successive years between 1926 and 1931 when he was doing some land settlement in Raipur district of Berar bordering Orissa. He found the experiment most interesting and this led to his renewed interest in the work that Mahalanobis was doing. Since 1939, he had been almost in continuous contact with Mahalanobis with regard to the work of the Institute. Deshmukh was appointed Governor of the Reserve Bank of India in 1943, knighted in 1944 and became the Minister of Finance, Government of India in 1950. His strong support enabled the Institute to secure a recurring grant of Rs. 4.5 lakhs from the Government of India from 1949-50, which helped to stabilize the Research and Training School of the Institute. The Indian Statistical Institute was fortunate in having him as President from 1945 to 1964 during which time he contributed very significantly to the development of the Institute. He not only helped Jawaharlal Nehru in the organization of the Planning Commission in 1950 but, as a member of the Planning Commission also took a leading part in the formulation of the First Five-Year Plan and gave his strong support to the strategy of rapid industrialization in the Second Five-Year Plan. He and Mahalanobis had also collaborated in establishing the National Sample Survey and the Central Statistical Organization.

Even when Mahalanobis was working on his planning models,

he had not stopped giving new ideas in statistical methodology. In 1958, he found a simple but very effective technique known as Fractile Graphical Analysis. In the different rounds of the National Sample Survey, which was started in 1950, a good deal of data were collected every year on the socio-economic conditions of the people. For example, the data collected included information on household budgets such as the total expenditure of a household, or the expenditure per person during a particular period, or the expenditure on individual items of consumption like food, clothes, medicines, etc. Such information was available for different levels of expenditure for the States as well as for India as a whole. An interesting question arose as to whether the pattern of consumption was the same in all the States or varied from one State to another or over different periods of time in the same State, etc. This led Mahalanobis to introduce his method of Fractile Graphical Analysis which answered the question effectively. The Fractile Graphical Analysis was first introduced by Mahalanobis in a lecture at the Indian Statistical Institute in April 1958 and it created widespread interest and the method was developed further in the USA in 1958 and later in Japan. Since then a good deal of research work has been done in the theoretical aspects of Fractile Graphical Analysis and considerable experience gained in its application in various fields.*

Incidentally, mention should be made here that, besides his four books, one each on jute census and statistical sampling, and two on planning, Mahalanobis also wrote a large number of scientific papers on anthropometry, meteorology, rainfall and flood control, agriculture, sample surveys, psychometry, demography, haematology, educational and vocational tests, labour economics, national income, operational research, statistical quality control, perspective planning, industrialization, technical manpower, social change and economic development, unemployment and under-employment, organization of science and technology, etc. (See Bibliography for complete list of published papers.)

*Mahalanobis, P.C. : "Extensions of Fractile Graphical Analysis". *Essays In Probability and Statistics, S.N. Roy Memorial Volume*, Statistical Publishing Society, Calcutta, 1969.

In 1950, the Indian Statistical Institute, while still located in the physics department of the Presidency College, collaborated with the International Statistical Institute to establish the International Statistical Education Centre (ISEC) in Calcutta under the sponsorship of UNESCO. This was a big step forward in international collaboration for the spread of education in statistics. Between 1950 and 1980, 885 trainees came from forty-six countries viz. Afghanistan, Australia, Bangladesh, Bhutan, Brunei, Burma, Cambodia, Taiwan, Ethiopia, Fiji Islands, Gambia, Hong Kong, India, Indonesia, Iran, Iraq, Israel, Japan, Kenya, Republic of Korea, Laos, Malaysia, Malawi, Maldives, Mauritius, Nepal, New Zealand, Nigeria, Pakistan, Philippines, Papua New Guinea, Sarawak, Sierra Leone, Singapore, Somalia, South Africa, Sri Lanka, St. Christopher, Nevis-Anguilla, Sudan, Thailand, Uganda, United Arab Republic, Vietnam, Western Samoa and Zambia, to study at this Centre located in the Indian Statistical Institute.

In 1951, after over twenty years of a cramped existence in a small portion of the physics department of the Presidency College, the Indian Statistical Institute shifted to its own spacious seven-storeyed building on Barrackpore Trunk Road. This gave the Institute an opportunity to act as the host society for the twenty-seventh session of the International Statistical Institute along with joint or associated meetings of other international organizations which constituted the International Statistical Conferences, India, 1951. The conferences were inaugurated by Dr. Rajendra Prasad, President of India, on 5 December 1951, in New Delhi, and a session of the Conferences was held in Calcutta in the new premises of the Indian Statistical Institute. Mahalanobis was the General Secretary of the National Committee and Chairman of the Programme Committee. Among those who attended the conference were about three hundred delegates from thirty-four countries and representatives of the United Nations and its Specialized Agencies such as the United Nations Educational, Scientific and Cultural Organization (UNESCO), Economic Commission for Asia and the Far East (ECAFE), Food and Agricultural Organization (FAO), International Labour Organization (ILO), and World Health Organization (WHO). This was the first time

that the International Statistical Conferences were held in India and they helped not only to awaken an interest in statistical activities in India but also to foster a sense of mutual understanding and cooperation among the people of the East and the West. The inauguration of the International Statistical Education Centre in 1950 and the holding of the International Statistical Conferences in 1951 also helped to create worldwide interest about the Indian Statistical Institute.

Mahalanobis was a scientific ambassador in the truest sense. His numerous tours abroad and his contacts with individual scientists and scientific organizations both in the western and socialist countries, helped considerably to strengthen the link between India and other countries of the world in the sphere of scientific collaboration. It was through his efforts that top-ranking statisticians, mathematicians and economists came to the Indian Statistical Institute to help in research projects of the Institute. In recognition of his contributions towards international collaboration in scientific research, he had the rare distinction of being made the first honorary foreign member of the Academy of Sciences of the USSR in 1958.

In the three decades since 1937 about six hundred leading scientists of the world came to the Indian Statistical Institute. Arrangements were also made for scientists of the Institute to go abroad under different programmes of international coorporation in science and technology. Among the many eminent persons who visited the Indian Statistical Institute on the invitation of Mahalanobis and stayed in Amrapali were nobel laureates. Lord P.M.S. Blackett of the United Kingdom, Dr. Ernst Boris Chain of Italy, Professor Frederic Joliot-Curie and, Madame Irene Joliot-Curie of France, Professor P.A.M. Dirac of the United Kingdom, Dr. Rangar Frisch of Norway, Sir Robert Robinson and Dr. R.L.N. Synge of the United Kingdom, Academician I.Y. Tamm of USSR and Dr. Jan Tinbergen of the Netherlands; a number of the Fellows of the Royal Society; Academicians of the Academy of Sciences, USSR; and scientists from the USA and other countries.

It would have been impossible for most of the research workers of the Indian Statistical Institute to meet such world-renowned

scientists as Ronald Fishers, J.B.S. Haldane, A.N. Kolmogorov, Yu. V. Linnik, Abraham Wald, and Norbert Wiener or economists like Paul Baran, Charles Bettelheim, Rangar Frisch, J.K. Galbraith, Oskar Lange, and Jan Tinbergen, to name a few, if Mahalanobis had not made arrangements for them to come and stay in the Institute.

Although the Indian Statistical Institute had started organized training courses in statistical methods from 1939 and the Research and Training School of the Institute was more or less stabilized with a recurring grant from the Government of India from 1949-50, it did not have any power to award degrees in statistics. Various suggestions were made since 1953 for converting the Institute into a university but this was not found quite suitable for higher education in statistics, which was essentially a technological subject. It was, however, agreed in 1955 that the Government would recognize the Institute in some suitable way as an institution of national importance. Subsequently, a Bill was introduced by Prime Minister Jawaharlal Nehru, in the Lok Sabha on 14 December 1959 and in the Rajya Sabha on 17 December 1959. After the Bill was passed by both Houses of Parliament, it became the Indian Statistical Institute Act (No. 57 of 1959), and was brought into operation from April 1960. The Act gave recognition to the Institute as an institution of national importance with powers to award degrees. Subsequently the Institute started courses of study leading to the degrees of Bachelor of Statistics (B. Stat.) and Master of Statistics (M. Stat.) from July 1960 and also made arrangements for the award of degrees of Ph.D. and D.Sc. in statistics. The courses were formulated in such a way as to enable students not only to learn the theory and methodology in the three basic subjects of mathematics, statistics and economics of planning, but also to acquire sufficient knowledge in different scientific disciplines.

It would be impossible, in the short compass of a biography, to describe in detail the enormous and varied work done by the Indian Statistical Institute. An idea of its growth could, perhaps, be had from the fact that in the year 1931, the Institute's staff comprised only four workers and its total expenditure in the first

year of its functioning was less than two hundred and fifty rupees (about fifty dollars), but four decades later the Institute had over two thousand workers on its rolls and had an annual budget of about two crore and thirty-five lakh rupees (about three million dollars). In 1932, the Institute was located in a small portion of the physics department of the Presidency College, but in 1972, the Institute had several large buildings of its own to provide working space for research and training in such diverse subjects as anthropometry, biochemistry, botany, computer science, crop science, demography, economics, human genetics, leaf protein, linguistics, mathematics, national income, planning, pre-census, population studies, psychometry, sociology, and statistics; and also hostels for students and scholars, staff quarters and guest houses. The Institute's activities were not confined within Calcutta but spread all over India.

While mentioning the subjects for which facilities for research and training are available in the Institute, it may be interesting to note that, as far back as in October 1916, when Mahalanobis was contemplating to return to Cambridge to continue his studies, he wrote a letter from Darjeeling to one of his cousins saying that after going back to Cambridge he had plans to study physics, mathematics, psychology, biology, physiology, zoology, embryology, botany, sociology, economics, educational theory, geology, astronomy, logic, philosophy, statistics, eugenics, archaeology, sculpture, painting, modern literature and Sanskrit. He, however, lamented that he might not have enough time to study all the subjects and was, therefore, obliged to keep Sanskrit reserved for study on his return to India. It was not known whether Mahalanobis's early desire to study these subjects found expression in the introduction of most of the subjects in the curriculum of studies in the Indian Statistical Institute, with, of course, the notable exception of Sanskrit.

The story of the Indian Statistical Institute will not be complete without the story of the dinosaur. It may indeed be a valuable addition to Ripley's 'believe it or not' stories if it is said that a dinosaur, about fifteen metres long, which roamed on this earth some one hundred and sixty million years ago, which found its way

into the precincts of the Institute. To make a long story short, this is how it happened. A team of scientists of the Geological Studies Unit of the Indian Statistical Institute, led by Dr. Pamela L. Robinson of the University College, London (who had been invited by Mahalanobis to come to the Indian Statistical Institute to set up the Geological Studies Unit), went to the Pranhita-Godavari Valley bordering Maharashtra and Andhra Pradesh in 1958 to hunt for fossil fish. By chance, they discovered, for the first time in India, the fossil bones of this giant prehistoric lizard, the largest animal that lived on earth. During the next few years, over ten tons of bone materials were collected from the valley and brought to Calcutta. The bones were assembled and later mounted in 1976, in record time into a full-length skeleton of the dinosaur in the Geological Studies Unit. The skeleton was named Barapasaurus Tagorei—Barapasaurus meaning big-legged lizard and Tagorei in whose birth centenary year the discovery was made. Thus, Barapasaurus Tagorei stood on its mount in the Geological Museum of the Indian Statistical Institute, attracting streams of visitors from different places for many days.

The late Sir Ronald A. Fisher had once compared the Indian Statistical Institute to the banyan tree with its many branches. Since 1961, the Institute adopted a crest with the banyan tree and the motto 'Unity in Diversity'. The design of the crest and the Sanskrit equivalent of the motto 'Bhinneshvai-kyasya Darshanam' were suggested by the Institute's President C.D. Desmukh. The Institute was truly like a great banyan tree with its many branches of activities in diverse fields spreading far and wide. There was, however, an underlying unity of purpose in all these activities : the promotion of research and knowledge. From a small seed planted years ago, the phenomenal growth of the banyan tree to its enormous size was possible because of the sagacity, foresight and dynamic leadership of one person : Prasanta Chandra Mahalanobis.

TOURS ABROAD, HONOURS, AWARDS AND THE LAST DAYS

Participation in International Conferences

IN THIS SHORT compass, it is difficult to give a detailed account of the many tours abroad undertaken by Mahalanobis in the twenty-five years from 1946. The international conferences attended by him, either in his individual capacity or as leader of a delegation from India, listed here may give some idea of the extent of his tours : Royal Society Conference London, Cambridge, Oxford, 1946; Joint Meeting of American Philosophical Society and National Academy of Sciences of USA, Philadelphia and Washington, 1946; World Statistical Congress, 1947; Biennial Sessions of the International Statistical Institute, Berne, 1949, Rome, 1953, Rio de Janeiro, 1955, Stockholm, 1957, Brussels, 1958. Tokyo, 1960, Paris, 1961, Sydney, 1967; Biennial Sessions of the International Population Union, Geneva 1949, Bellagio (Italy), 1953; International Congress of Mathematicians, Harvard University, 1950; Scientific Delegation to USSR Academy of Sciences 1951, 1954; International Economic Conference, Moscow, 1952; ECAFE Conference of Statisticians, Bangkok, 1952; International Conference on Income and Wealth, Caster Gondolphi (Italy) 1953; International Symposium on Statistics, Federal Institute of Technology, Zurich 1953; World Population Conference, Rome, 1954; Pakistan Statistical Conference, 1956; International Conference on Operations Research, Oxford, 1957; the Third Pugwash Conference of Scientists, Kitzbuhel 1958, London 1962; International Conference on Economic Development of Less Advanced Countries, Geneva 1961; Conference for International Cooperation and Partnership, Vienna 1962; United Nations Conference on the Application of Science and Technology for the Benefit of the Less Developed

Areas, Geneva, 1963; China Conference in the Centre for Continuing Education, University of Chicago, 1966; Conference of Labour Statisticians, Geneva, 1966; International Conference on Computer Science, Cairo, 1969; Conference on New Directions for Asia, Manila, 1970.

Honours and Awards

Mahalanobis received a number of awards and honours in India and abroad for his outstanding and fundamental contributions to statistics and planning. He was elected Fellow of the Royal Society, London (1945), Chairman of United Nations Sub-Commission on Statistical Sampling (five sessions—1947-1951), Vice President of International Biometric Society (1947), General President of Indian Science Congress (1950), Fellow of International Econometric Society (1951), Fellow of Pakistan Statistical Association (1952), Correspondent Councillor, Consejo Superior, Institute of Statistical Research, Madrid (1953), Chairman of United Nations Statistical Commission (1954-1958), Honorary Fellow, Royal Statistical Society, London (1954), Honorary President, International Statistical Institute (1957), President of National Institute of Sciences of India (1957 and 1958), Foreign Member, USSR Academy of Sciences (1958), Honorary Fellow, King's College, Cambridge (1958), Fellow of American Statistical Association (1961) and Fellow of World Academy of Art and Science (1963). He received the Weldon Medal from Oxford University (1944), Sir Devaprasad Sarbadhikari Gold Medal from Calcutta University (1957), Gold Medal from Czechoslovak Academy of Sciences (1964), Durga Prasad Khaitan Memorial Gold Medal from Asiatic Society (1968), and Srinivasa Ramanujam Gold Medal (1968). Mahalanobis received the Honorary Deshikottama from Visva-Bharati University (1961) and the Padma Vibhusan (1968). He also received honorary doctorates from Calcutta University (1957), Sofia University (1961), Delhi University (1964) and Stockholm University (1966).

The Last Days

In June 1971, Mahalanobis went to New York, accompanied by his wife, to submit a report to the United Nations as a Consultant.

From June 29 to October 21 of that year, despite some health problems, he was busy visiting, first the USA and then the United Kingdom, Sweden, Yugoslavia and the USSR for attending meetings and conferences, delivering lectures and having scientific discussions. Little did he know at that time that it would be his last visit abroad.

From early 1972, he started feeling unwell, and on the twenty-fourth of May of that year, he was admitted into a nursing home in Calcutta to undergo an abdominal operation on 7 June 1972. He stood the operation well and there were high hopes that, with his immense vitality, he would be able to recover and go back home. But that was not to be. Mahalanobis seems to have had a short of premonition of what was to happen. He told Nirmal Kumari Mahalanobis, who was with him all the time, that she would not be able to take him back to Amrapali, and that he would not live till the twenty-ninth of June which was his birthday. And how true it proved to be. After twenty-one days of intense suspense, mingled with hope and despair for all those around him since his operation, he passed away on 28 June 1972—just a day before his birthday. His mind was clear till the last moment. Even two hours before his death, he had discussed some administrative matters regarding the Indian Statistical Institute. Though dead, he lives on in the minds of those who cherish his memory with affection and regards and love the great institution he built.

BIBLIOGRAPHY

Scientific Contributions of Professor P.C. Mahalanobis

1919

1. A new coefficient of correlation with applications to some biological and sociological data. (*Abstract*) *Proc. Ind. Sci. Cong.* (*Bombay*). Sec. 6, and *Proc. Asiatic Society of Bengal*. New Series **15**, (4); cxxiii.

1920

2. On the stability of anthropometric constants for Bengal caste data. (*Abstract*) *Proc. Ind. Sci. Cong.* (*Nagpur*). *Physics and Mathematics Sec. 7*, and *Proc. Asiatic Society of Bengal*. New Series. **16**, lv-lvi.
3. Statistical notes on anthropometric sub-group constants for Bengal caste data. (*Abstract*) *Proc. Ind. Sci. Cong.* (*Nagpur*), *Physics and Mathematics Sec. 7*, and *Proc. Asiatic Society of Bengal*. **16**, lvi.
4. (and Mukherji Sasanka Sekhar) : On the new compensated ballistic method for magnetic measurements, with a preliminary note on the magnetic behaviour of nickel in the form of powder under different physical stimuli. (*Abstract*) *Proc. Ind. Sci. Cong.* (*Nagpur*) *Physics and Mathematics Section 7*, and *Proc. Asiatic Society of Bengal*. New Series. **16**, 1920, iv.

1921

5. Note on the criterion that two samples are samples of the same population. (*Abstract*) *Proc. Ind. Sci. Cong.* (*Calcutta*). Sec. *Physics and Mathematics*, 8, and *Proc. Asiatic Society of Bengal*. New Series. **17**, cxvii-cxviii.
6. The statistical constants of an Anglo-Indian sample : Part I : II

Head length and head breath. (*Abstract*) *Proc. Ind. Sci. Cong. (Calcutta)*, 8 and *Proc. Asiatic Society of Bengal*. New Series 17, ccxlvii-ccxlviii.

1922

7. Anthropological observations on the Anglo-Indians of Calcutta. Part I : Analysis of male stature. *Rec. Ind. Museum.* 23, 1-96.
8. On the correction of a coefficient of correlation for observational errors (*Abstract*) *Proc. Ind. Sci. Cong. (Madras) Physics and Mathematics Section* 9, and *Four. and Proc. Asiatic Society of Bengal*. New Series. XVIII, (6); 54.
9. On the probable error of the component frequency constants of a dissected frequency curve (*Abstract*). *Proc. Ind. Sci. Cong. (Madras) Physics and Mathematics Sec. and 9, Four and Proc. Asiatic Society of Bengal*. New Series. XVIII, (6) ; 54.
10. On the probable error of constants obtained by linear interpolation. (*Abstract*) *Proc. Ind. Sci. Cong. (Madras) Physics and Mathematics Sec. 9, 54. Four. and Proc. Asiatic Society of Bengal*. New Series. XVIII, (6) ; 5 .
11. On upper air correlations. (*Abstract*) *Proc. Ind. Sci. Cong. (Madras) Physics and Mathematics Sec. 9, Four. and Asiatic Society of Bengal*. New Series. XVIII, (6) ; 53-54.

1923

12. Correlation of upper air variables, *Nature*. 112. 323-324.
13. On errors of observation and upper air relationship. *Memoirs Ind. Met. Dept.* 24, 11-19.
14. On the seat of activity in the upper air. *Memoris Ind. Met. Dept.* 24, 1-9.
15. Statistical note on the significant character of local variation in the proportion of dextral and sinistral shells in samples of the snail *Buliminus Dextro Sinister* from the salt range, Punjab. *Rec. Ind. Museum.* 25, 399-403.

1924

16. New method of computing the rate of standard clocks. (*Abstract*) *Proc. Ind. Sci. Cong. (Bangalore) Sec. Mathematics and Physics.* **11**, 65.
17. On the probable error of interpolation for parabolic curves. (*Abstract*) *Proc. Ind. Sci. Cong. (Lucknow) Sec. Phys. & Maths.* **10**, 77.
18. Statistical analysis of five independent samples of *cardina nilotica* var *gracilipes*. (*Abstract*) *Proc. Ind. Sci. Cong. (Lucknow) Sec. Phys & Maths.* **10**, 82.
19. Statistical studies in meteorology. (*Abstract*) *Proc. Ind. Sci. Cong. (Bangalore) Sec. Mathematics and Physics.* **11**, 48-49.

1925

20. Analysis of race-mixture in Bengal. Presidential Address, Anthropological Section, *Ind. Sci. Cong.* (Edited). and *Four. and Proc. Asiatic Society of Bengal.* **23**, 1927, 301-33. Published separately, 1928.
21. Probable error of field experiments in agriculture. *Agri. Four. Ind.* **20**, 96-116.

1926

22. Anthropometric survey of India. (*Abstract*) *Proc. Ind. Sci. Cong. (Bombay) Sec. Anthropology.* **13**, 320.
23. Appendicitis, rainfall and bowel complaints by Capt. S.K. Ray. Part II : Scope of the enquiry, by [P.C. Mahalanobis]. *Cal. Med. Four.* **21(4)**, 151-187, Discussion 213.
24. Correlation and variation of normal rainfall for July, August and September in North Bengal. (*Abstract*) *Proc. Ind. Sci. Cong. (Bombay) Sec. Mathematics and Physics.* **13**, 68.
25. Local variations of specimens of *cardina nilotica* var *gracilipes*. (*Abstract*) *Proc. Ind. Sci. Cong. (Bombay) Zoology Section.* **13**, 190.

1927

26. Report on rainfall and flood in North Bengal during the period 1870-1922. (In 2 volumes with 29 tables and 28 maps), submitted to the Government of Bengal, 1-90. *Ind. Sci. Cong.*

(Bombay) Section Mathematics and Physics. (Abstract) [Title : Rainfall in relation to floods in North Bengal]. **13**, 1926, 67p.

1928

27. On the need for standardization in measurements on the living. *Biometrika*, **20A**, 1-31. (Abstract). *Proc. Ind. Sci. Cong. (Calcutta)* [Title : "A first study of Chinese head".] **15**, 1928, 325.
28. Statistical study of the Chinese head. *Man in India*, **8** 107-122. *Proc. Ind. Sci. Cong. (Calcutta). Sec. Anthropology*, (Abstract) [Title : "A first study of Chinese head".] **15**. 1928, 325.

1930

29. On tests and measures of group divergence, Part I : Technical formulae. *Four. and Proc. Asiat. Soc. Bengal. New Series* **26**, 541-518.
30. Statistical study of certain anthropometric measurements from Sweden. *Biometrika*, **22**, 94-108. (Abstract) *Proc. Sci. Cong. (Allahabad) Sec. Anthropology*. **17**, 396.
31. Anthropological observations on the Anglo-Indians of Calcutta. Part II : Analysis of Anglo-Indian head length. *Rec. Ind. Museum*. **23**, 97-149. (Abstract) *Proc. Ind. Sci. Cong. (Nagpur). Sec. Anthropology* **18**, 411.

1931

32. Application of statistics to agriculture. *Proc. Ind. Sci. Cong. (Nagpur) Section Agriculture*, General discussion. **18**, 446-447.
33. On the normalization of statistical variates. (Abstract) *Proc. Ind. Sci. Cong. (Nagpur) Sec. Mathematics and Physics* **18**, 91-92. [See also 140].
34. Revision of Risley's anthropometric data relating to the tribes and castes of Bengal. (Title with slight alteration) (Abstract) *Proc. Ind. Sci. Cong. (Nagpur)*. **18**, 1931, 411. *Sankhyā*. **1**, 1933, 76-105.
35. Studies in group tests of intelligence : (1) The reliability and age-normals of scores in Form (A). (Abstract) *Proc. Ind. Sci. Cong. (Nagpur) Sec. Psychology*. **18**, 437.

1932

36. Auxiliary tables for Fisher's Z-test in analysis of variance. (Statistical notes for agricultural workers, no. 3). *Ind. Four. Agri. Sci.* 2, 679-693.
37. Revision of Risley's anthropometric data relating to the Chittagong hill tribes. (*Abstract*) *Proc. Ind. Sci. Cong. (Bangalore) Anthropology. Sec.* 19, 424, *Sankhyā*, 1, 1934, 267-276.
38. Rice and potato experiments at Sriniketan. (Agricultural Department of the Visva-Bharati) 1931. (Statistical notes for agricultural workers, No. 4). *Ind. Four. Agri. Sci.* 2, 69-703. (*Abstract*) *Proc. Ind. Sci. Cong. (Patna) Sec. Agriculture.* 20, 1933, 48.
39. A statistical analysis of the height of the Brahmani River at Jenapore. (*Abstract*) *Proc. Ind. Sci. Cong. (Bangalore). Sec. Mathematics and Physics.* 19, 123.
40. Statistical note on certain rice breeding experiments in the Central Provinces. *Ind. Four. Agri. Sci.* 2, 157-169. (*Abstract*) *Proc. Ind. Sci. Cong. (Bangalore) Sec. Agriculture statistical methods.* 19, 88.
41. Statistical note on the method of comparing mean values based on small samples. *Ind. Four. Agri. Sci.* 2, 28-41. (*Abstract*) *Proc. Ind. Sci. Cong. (Bangalore) Sec. Agriculture statistical methods.* 19, 88.
42. (and Bose, S.S.) ; A first study of sampling experiments on the effect of systematic arrangements in field trials. (*Abstract*) *Proc. Ind. Sci. Cong. (Bangalore) Sec. Agriculture statistical methods.* 19, 88.
43. (and Bose, S. S.) : Note on the variation of the percentage infection of Wilt disease in the cotton (Statistical notes for agricultural workers, No. 5). *Ind. Four. Agri. Sci.*, 2, 704-709. (*Abstract*) *Proc. Ind. Sci. Cong. (Patna) Section Agriculture Statistics.* 20, 1933, 48.

1933

44. A comparison of different statistical measures of intelligence based on a group test in Bengal. (*Abstract*) *Proc. Ind. Sci. Cong. (Patna) Section Psychology.* 20, 439.

45. Editorial. *Sankhyā*. 1, 1-4.
46. Effects of fertilizers on the variability of the yield and rate of shedding of buds and flowers and bolls in the cotton plant in Surat. (Statistical notes for agricultural workers, No. 6). *Ind. Four. Agri. Sci.* 3, 131-138. (*Abstract*) *Proc. Ind. Sci. Cong. (Patna) Sec. Agriculture Statistics* 20, 46.
47. A new photographic apparatus for recording profiles of living persons. (*Abstract*) *Proc. Ind. Sci. Cong. (Patna) Sec. Anthropology*. 20, 413.
48. On the need of randomization of plots in field trials. (Statistical notes for agricultural workers, No. 13) *Ind. Four. Agri. Sci.* 3, 549-551. (*Abstract*) *Proc. Ind. Sci. Cong. (Patna) Sec. Agriculture Statistics*. 20, 48.
49. The reliability of a group test of intelligence in Bengali. (with five figures). Studies in educational test, No. 1). *Sankhyā*. 1, 25-49.
50. A study of the correlation between the height of Brahmani at Jenapore and the rainfall in the catchment area. (*Abstract*) *Proc. Ind. Sci. Cong. (Patna) Sec. Mathematics and Physics*. 20, 123.
51. Tables for the application of Neyman and Pearson's L test for judging the significance of observed divergence in mean values and variabilities of K samples. (*Abstract*) *Proc. Ind. Sci. Cong. (Patna) Sec. Mathematics and Physics*. 20, 123.
52. Tables for comparing standard deviations of small samples. (*Abstract*) *Proc. Ind. Sci. Cong. (Patna) Sec. Mathematics and Physics*. 20, 122.
53. Tables for L-tests. *Sankhyā* 1, 109-122. Published as pamphlet. Calcutta, Statistical Laboratory, 14 pp.
54. Use of the method of paired differences for estimating the significance of field trials. (Statistical notes for agricultural workers, No. 11). *Ind. Four. Agri. Sci.* 3, 349-352. (*Abstract*) *Proc. Ind. Sci. Cong. (Patna) Agriculture statistics section*. 20, 41.
55. Use of random sampling numbers in agricultural experiments. Statistical notes for agriculture workers, No. 14). *Ind. Four. Agri. Sci.* 3, 1108-1115.

56. (and Basak, K. C.) : A study of the intensity of floods in the Mahanadi for the period 1868-1929. (*Abstract*) *Proc. Ind. Sci. Cong.* (*Patna*) *Sec. Mathematics and Physics*. **20**, 124.
57. (and Bose, S. S.) : Analysis of a manurial experiment on wheat conducted at Sakrand, Sind. (Statistical notes for agricultural workers, No. 10). *Ind. Four. Agri. Sci.* **3**, 345-348.
58. (and Bose, S.S.) : Analysis of varietal tests with wheat conducted at Sakrand, Sind, 1931-32. (Statistical notes for agricultural workers, No. 12). *Ind. Four. Agri. Sci.* **3**, 544-548. (*Abstract*) *Proc. Ind. Sci. Cong.* (*Patna*) *Sec. Agriculture Statistics*. **20**, 47.
59. (and Bose, S. S.) : Certain varietal studies on the cotton plant in Surat. Statistical notes for agricultural workers, No. 9). *Ind. Four. Agri. Sci.* **3**, 339-344.
60. (and Bose, S. S.) : Effect of different doses of nitrogen on the rate of shedding of buds, flowers and bolls in the cotton plant in Surat. (Statistical notes for agricultural workers, No. 8). *Ind. Four. Agri. Sci.* **3**, 147-154. (*Abstract*) *Proc. Ind. Sci. Cong.* (*Patna*) *Sec. Agriculture Statistics*. **20**, 47.
61. (and Bose, S. S.) : Effect of the time of application of fertilizers on the yield and the rate of shedding of buds, flowers and bolls in the cotton plant in Surat. (Statistical notes for agricultural workers, No. 7) *Ind. Four. Agri. Sci.* **3**, 139-146. (*Abstract*) *Proc. Ind. Sci. Cong.* (*Patna*) *Agriculture Statistics Sec.* **20**, 47.
62. (and Bose, S. S.) : A study of the intensity of floods in the Brahmaputra for the period 1868-1929. (*Abstract*) *Proc. Ind. Sci. Cong.* (*Patna*) *Sec. Maths. and Phys.* **20**, 124.
63. (and Chakravarti, Nistaran) : A study of the precipitation and the percentage run-off in the Mahanadi. (*Abstract*) *Proc. Ind. Sci. Cong.* (*Patna*) *Mathematics and Physics Sec.* **20**, 124.
64. (and Dass Kedarnath) : A preliminary note on the rates of maternal deaths and still-births in Calcutta. *Sankhyā*. **1**, 215-230.
65. (and Nag, A.C.) : A study of the correlation of rainfall during rain storms in the Mahanadi catchment. (*Abstract*) *Proc. Ind. Sci. Cong.* (*Patna*) *Mathematics and Physics*. **20**, 123.

66. (and Ray, P.R.) : A study of the correlation of the height of Mahanadi at Sambalpur and at Naraj. (*Abstract*) *Proc. Ind. Sci. Cong. (Patna) Mathematics and Physics Sec.* **20**, 124.
67. (and Sen, R. N.) : A study of the seasonal fluctuations in the height of the Orissa rivers. (*Abstract*) *Proc. Ind. Sci. Cong. (Patna) Mathematics and Physics Sec.* **20**, 124.

1934

68. Age variation of scores in a group test of intelligence in Bengali (with eight figures). (*Studies in educational tests*, No. 2.) *Sankhyā*. **1**, 231-244.
69. A statistical analysis of rotational experiments with cotton, groundnut, and juar in Berar, with notes on designs of rotational experiments. (*Statistical notes for agricultural workers*, No. 15.) *Ind. Four. Agri. Sci.* **4**, 361-385. (*Abstract*) *Proc. Ind. Sci. Cong. (Bombay) Sec. Agricultural Statistics.* **21**, 69.
70. [Note by Editor appended to] "Tables for testing the significance of linear regression in the case of time-series and other single-value samples by Bose, S. S" *Sankhyā*. **1**, 284.
71. [Note by Editor appended to] "Thirty-eight years of rice yields in lower Birbhum, Bengal by Hashim Amir Ali, assisted by Tara Krishna Bose." *Sankhyā*. **1**, 387-389.
72. On the statistical divergence between certain species of phytophthora. (*Abstract*) *Proc. Ind. Sci. Cong. (Bombay) Sec. Mathematics and Physics.* **21**, 151.
73. A preliminary note on intervarietal correlation in the rice plant in Bengal. (*Abstract*) *Proc. Ind. Sci. Cong. (Bombay) Sec. Agricultural Statistics.* **21**, 70.
74. A preliminary study of the intelligence quotient of Bengali school children. (With ten figures.) (*Studies in educational tests*, No. 4.) *Sankhyā*. **1**, 407-426.
75. (and Bose, S. S.) : Effect of different types of soil-covers on the moisture economy of irrigated plantations of *Dalbergia Sissoo* in Lahore Division. (*Abstract*) *Proc. Ind. Sci. Cong. (Bombay) Sec. Agricultural Statistics.* **21**, 70.
76. (and Bose, S. S.) : Statistical note on the effect of pests on the yield of sugarcane and the quality of cane-juice. *Sankhyā*. **1**,

- 399-496. (*Abstract*) *Proc. Ind. Sci. Cong. (Bombay) Sec. Agricultural Statistics.* **21**, 71.
77. (and Bose, S. S., Ray, P. R. and Banerjee, S. K.) : Tables for random samples from a normal population. *Sankhyā* **1**, 289-328. Pamphlet, Calcutta, Statistical Laboratory, pp. 40.
78. (and Chakravarti, K. N.) : Analysis of marks in the school leaving certificate examination in the United Provinces, India, 1919 (with ten figures). *Studies in educational tests*, No. 3). *Sankhyā*. **1**, 245-266.
79. (and Chakravortti, S. C. and Banerjee, E. A. R.) : Influence of shape and size of plots on the accuracy of field experiments with rice, Chinsurah, Bengal. (*Abstract*) *Proc. Ind. Sci. Cong. (Bombay) Sec. Agricultural Statistics.* **21**, 71
80. (and Das, Kedarnath and Nag, Anil Chandra) : A preliminary note on the rates of maternal deaths and still-births in Calcutta. *Sankhyā*. **1**, 215-230.
81. (and Nag, A. C.) : A preliminary study of the maternal death-rate and the proportion of still-births in Bengal for the period 1848-1901. (*Abstract*) *Proc. Ind. Sci. Cong. (Bombay) Sec. Medical and veterinary research.* **21**, 380.
- 1935
82. Analysis of racial likeness in Bengal castes. (*Abstract*) *Proc. Ind. Sci. Cong. (Calcutta) Anthropology. Sec.* **22**, 335.
83. Application of statistical method in industry. *Science and Culture.* **1**, 73-78.
84. [An Editorial correction to] "On the distribution of the ratio variances of two samples drawn from a given normal bivariate correlated population, by Bose, S. S." *Sankhyā*, **2**, 72.
85. Further studies of the Bengali profile (*Abstract*) *Proc. Ind. Sci. Cong. (Indore) Anthropology*, Sec. **22**, 337.
86. On the validity of a group test of intelligence in Bengal [i]. (*Abstract*) *Proc. Ind. Sci. Cong. (Calcutta) Psychology Sec.* **22**, 446.
87. A statistical note on certain haematological studies of fifty new-born. (*Abstract*) *Proc. Ind. Sci. Cong. (Calcutta) Sec. Medicine & veterinary research.* **22**, 411.
88. (and Banerjee, K. C. and Ray, P. R.) : Studies in tiller-forma-

- tion. (*Abstract*) *Proc. Ind. Sci. Cong. (Calcutta) Sec. Agricultural Statistics.* **22**, 347.
89. (and Bose, R. C.) : On the generalised statistical distance between samples from two normal populations. (*Abstract*) *Proc. Ind. Sci. Cong. (Indore) Sec. Mathematics & Physics.* **22**, 80.
90. (and Bose, S. S.) ; Extension of X table (corresponding to Fisher's Z-table) for testing the significance of two observed variances. (*Abstract*) *Proc. Ind. Sci. Cong. (Indore) Sec. Mathematics and Physics.* **22**, 79.
91. (and Bose, S. S.) : A note on the application of multiple correlation for estimating the individual digestibilities of a mixed feed. (*Abstract*) *Proc. Ind. Sci. Cong. (Calcutta) Sec. Agricultural Statistics.* **22**, 348.
92. (and Bose, S. S.) : On estimating individual yields in the case of mixed-up yields of two or more plots in agricultural experiments. *Science and Culture* **1**, 205. [Slightly altered title "...plots in field experiments"] *Sankhyā*. **4**, 1938, 103-111.
93. and Bose, S. S. and Chakravarti, S. C.) : A complex cultural experiment with rice. (*Abstract*) *Proc. Ind. Sci. Cong. (Calcutta) Agricultural Statistics Sec.* **22**, 347. [altered title] "Complex experiment on rice at the Chinsurah farm, Bengal, 1933-34" (Statistical notes for agricultural workers, No. 16). *Ind. Four. Agri. Sci.* **6**, 34-51).
94. and Bose, S. S. and Harrison, C. J.) : Effect of manorial dressings, weather conditions and manufacturing processes on the quality of tea at Tocklai experimental station, Assam. *Sankhyā*. **2**, 33-42.
95. (and Bose, S. S. and Menon, T. V. G.) : A statistical study under permanent manurials in Pusa. (*Abstract*) *Proc. Ind. Sci. Cong. (Calcutta) Sec. Agricultural Statistics.* **22**, 348.
96. (and Bose, S. S. and Ray Choudhuri, S) : A bivariate sampling experiment. (*Abstract*) *Proc. Ind. Sci. Cong. (Calcutta) Sec. Mathematics & Physics.* **22**, 80.
97. (and Das, P. C. and Ray Choudhury, N. K.) : A statistical analysis of hospital records of some delivery cases in Calcutta (*Abstract*) *Proc. Ind. Sci. Cong. (Calcutta) Sec. Medical and veterinary research.* **22**, 410.

98. (and Menon, T. V. G. and Bose, S. S.) : A statistical study of soil deterioration in the permanent manurial experiments in Pusa. (*Abstract*) *Proc. Ind. Sci. Cong. (Calcutta) Sec. Agricultural statistics*, **22**, 348.
99. (and Nandi, G. C. Dhar, J. and Sen, S.) Relation between heights and weights of Bengali women. (*Abstract*) *Proc. Ind. Sci. Cong. (Calcutta) Sec. Medical and veterinary research*. **22**, 410.
100. (and Ray, K. C.) : A statistical method of testing the genuineness of a sample of ghee. (*Abstract*) *Proc. Ind. Sci. Cong. (Calcutta) Sec. Medical and veterinary research*. **22**, 410.

1936

101. Appendix 1 : Editorial note on the fundamental formulae. [to] : "The yield of Andropogon Sorghum in relation to circumference of head, length of head and height of plant by Venkataramanen, S. N." *Sankhyā*. **2**, 263-272.
102. Editorial note on the margin of error in the calculation of the cost of cultivation and profit Appended to 'Marketing of rice at Bolpur, by Satya Priya Bose'. *Sankhyā*. **2**, 121-124.
103. Karl Pearson, 1857-1936. (Lecture delivered at Statistical Laboratory, Calcutta, 27.11.1936.) *Sankhyā*. **2**, 303-378.
104. New theory of ancient Indian chronology. *Sankhyā*. **2**, 309-320.
105. (and Roy, S.) : School marks and intelligence test scores. *Sankhyā*. **2**, 397-402.
106. Note on the statistical and biometric writings of Karl Pearson (with references). *Sankhyā*. **2**, 411-422.
107. Note on cotton prices in relation to quality and yield. *Sankhyā*. **2**, 135-142.
108. Note on the use of indices in anthropometric work. *Science and Culture*. **1**, 477. (*Abstract*) *Proc. Ind. Sci. Cong. (Indore) Sec. Anthropology*. **23**, 392.
109. On the generalized distance in statistics. *Proc. Nat. Inst. Sci., India*. **11**, (1), 49-55.
110. On the generalized measure of divergence between statistical groups. (*Abstract*) *Proc. Ind. Sci., Cong. (Indore) Sec. Mathematics and Physics*. **23**, 108.

111. Sir Rajendra Nath Mookerjee : First President of the Indian Statistical Institute 1931-1936. *Sankhyā*. **2**, 237-240.
112. (and Acharya, D.P.) : A statistical study of marks in the annual and test examinations in relation to university results in I.A. and I.Sc. examinations in Bengal. (*Abstract*) *Proc. Ind. Sci. Cong. (Indore) Sec. Psychology*. **23**, 536.
113. (and Banerjee, K. C. and Bose, S. S.) : The influence of the date of planting and the number of seedlings per hole on tillering in rice at Bankura. (*Abstract*) *Proc. Ind. Sci. Cong. (Indore) Sec. Agriculture*. **23**, 437.
114. (and Bose, Raj Chandra, and Ray, S. N.) : On the evalution of the probability integral of the D^2 statistics. (*Abstract*) *Proc. Ind. Sci. Cong. (Indore) Sec. Mathematics and Physics*. **23**, 107.
115. (and Bose, S. S.) : On the estimate of missing yields in a splitplot type of arrangement. (*Abstract*) *Proc. Ind. Sci. Cong. (Indore) Sec. Agriculture*. **23**, 426.
116. (and Bose, S. S.) : On the estimate of mixed-up yields in an agricultural field experiment. (*Abstract*) *Proc. Ind. Sci. Cong. (Indore). Sec. Agriculture*. **23**, 426.
117. (and Bose, S. S.) A situation experiment with rice. (*Abstract*) *Proc. Ind. Sci. Cong. (Indore). Sec. Agriculture*. **23**, 437.
118. (and Bose, S. S. and Banerjee, K. C.) : Studies in tiller variation. (Statistical notes for agricultural workers, No. 20). *Ind. Four. Agri. Sci.* **6**, 1122-1133.
119. (and Bose, S. S. and Chakravarti, S. C.) : Effect of different methods of harvest on the estimated error of field experiments on rice. Statistical notes for agricultural workers, No. 21). *Agri. Live-stock in India*. **6**, 814-825.
120. (and Bose, S. S. and Ganguly, P. M.) : Frequency distribution of plot yields and optimum size of plots in a uniformity trial with rice in Assam. (Statistical notes for agricultural workers, No. 19). *Ind. Four. Agri. Sci.* **6**, 1107-1121.
121. (and Bose, S. S. and Kulkarni, R. K.) : On the influence of shape and size of plots on the effective precision of field experiments with juar (*Andropogon Sorghum*). (Statistical

- notes for agricultural workers, No. 17). *Ind. Four. Agri. Sci.* 6, 460-474.
122. (and Bose, S. S. and Sengupta, S. C.) : Statistical analysis of manurial experiment on Napier grass (*Pennisetum Perpureum*) by the method of covariance. (Statistical notes for agricultural workers, No. 18). *Agri. Live-stock in India.* 6, 183-194.
123. (and Chakraverti, S. C. and Bose, S. S.) : A complex cultural experiment with rice at Chinsurah, Bengal, for the year 1934-35. (*Abstract*) *Proc. Ind. Sci. Cong. (Indore) Sec. Agriculture.* 23, 436.
124. (and Guha Roy, K. K.) : Statistical methods and their applications to agronomy—a bibliography. *Misc. Bul.*, No. 9, Coun. Agri. Res. India, 120p.
125. (and Gupta, J. C.) : A preliminary note on measurements of blood pressure. (*Abstract*) *Proc. Ind. Sci. Cong. (Indore) Sec. Medical veterinary research.* 23, 485.
126. (and Roy, S.) : School marks and intelligence test scores. *Sankhyā.* 2, 397-402.
127. (and Sen, J. C.) : A comparative study of measures of intelligence. (*Abstract*) *Proc. Ind. Sci. Cong. (Indore) Sec. Psychology.* 23, 536.

1937

128. Need of a sample survey of the growth of population in India. *Sankhyā.* 3, 58.
129. A note on forecasting value of intelligence test. (*Abstract*) *Ind. Sci. Cong. (Hyderabad) Sec. Psychology.* 24, 448.
130. Variation of rainfall with lunar periods in Calcutta for the month of July (*Abstract*). *Proc. Ind. Sci. Cong. (Indore) Sec. Mathematics and Physics.* 23, 92. [altered title] "Note on the influence of lunar phase on the rainfall in the month of July in Calcutta, 1878-1924". *Sankhyā.* 3, 233-238.
131. On the accuracy of profile measurements with a photographic profiloscope. *Sankhyā.* 5, 65-72. [Slightly altered title] : "Studies with the photographic profiloscope." (*Abstract*) *Proc. Ind. Sci. Cong. (Indore) Anthropology Sec.* 23, 391.
132. Rectangular co-ordinates in sampling distributions : Appendix (Note). *Sankhyā.* 3, 35.

133. Review of the application of the statistical theory to agricultural field experiments in India. *Proc. Second meeting Crops. and Soils Wing, Board of Agriculture and Animal Husbandry, Lahore*, 6 December, Govt. of India, 1-15 [1]. Revised paper, *Ind. Four. Agri. Sci.* **10**, 192-212.
134. (and Bose, R. C. and Roy, S. N.) : The use of intrinsic rectangular coordinates in the theory of distribution. (*Abstract*) *Proc. Ind. Sci. Cong. (Hyderabad) Sec. Mathematics and Physics.* **24**, 99.
135. (and Bose, R. C. and Roy, S. N.) : Normalization of statistical variates and the use of rectangular co-ordinates in the theory of sampling distributions. *Sankhyā*. **3**, 1-34. Appendix by P. C. Mahalanobis. 35-40.
136. (and Acharya, D. P.) : Note on the correlation between results in the college and university examinations. *Sankhyā*. **3**, 239-244.
137. (and Bose, S. S.) : On an exact test of association between the occurrence of thunderstorm and an abnormal ionisation. *Sankhyā*. **3**, 249-252. [Slightly altered title] : "On a method of testing the association between thunderstorm and upper air ionisation." (*Abstract*) *Proc. Ind. Sci. Cong. (Hyderabad) Sec. Mathematics and Physics.* **24**, 99.
138. (and Datta, B. N.) : Note on the foot and stature correlation of certain Bengali castes and tribes. *Sankhyā*. **3**, 245-248.

1938

139. First session of the Indian Statistical Conference, Calcutta, 1938. *Sankhyā*. **4**, 1-4.
140. Note on grid sampling. *Science and Culture*, **4**, 300.
141. On the distribution of Fisher's taxonomic coefficient. (*Abstract*) *Proc. Ind. Sci. Cong. (Calcutta) Sec. Mathematics and Physics.* **52**, III; 31.
142. On an improved model of the profiloscope. (*Abstract*) *Proc. Ind. Sci. Cong. (Calcutta) Sec Anthropology.* **25**, 206.
143. Professor Ronald Aylmer Fisher. *Sankhyā*. **4**, 265-272. *Biometrics* (with few minor editorial amendments). **20**, 238-251.
144. (and Banerjee, K. C. and Pal, J. R.) : Study on tillers of rice

plant bearing on their duration on life, and performance and death. *Sankhyā*. 4, 149, (*Abstract*) *Proc. Ind. Sci. Cong. (Calcutta) Sec. Agriculture*. 25, pt. III; 220.

145. (and Bose, S. S.) : Test of significance of treatment means with mixed-up yields in field experiments. (*Abstract*) *Proc. Ind. Sci. Cong. (Calcutta) Sec. Agriculture*. 25, pt. III, Sec. IX. 219.
146. (with Chakravarty, S. C., Bose, S. S.) : Complex cultural experiment of rice (*Abstract*) *Sankhyā*. 4, 149.
147. (and Hedayetullah, S., Roy, K. P.) : Complex experiment of winter at Dacca. [1936- 37] *Sankhyā*. 4, 149-150. (*Abstract*) *Proc. Ind. Sci. Cong. (Calcutta) Sec. Agri.* 25, pt III, Sec. IX, 220.

1939

148. Enquiry into the prevalence of drinking tea among middle class Indian families in Calcutta, 1939. Submitted to the Tea Market Expansion Board, 1939. *Sankhyā*. 6, 1943, 283-312.
149. A note on grid sampling. (*Abstract*) *Proc. Ind. Sci. Cong. (Lahore)*. Sec. Maths & Phys. 26, Pt III, Sec I, 7.
150. Review of the application of statistical theory to agricultural field experiments in India. *Proc. Second Mtg. Crops and Soils Wing. Agri. India*. 200-215.
151. Subhendu Sekhar Bose, 1906-1932. *Sankhyā*. 4, 313-336.
152. The technique of random sample survey. (*Abstract*) *Proc. Ind. Sci. Cong. (Lahore)*. Sec. Theoretical statistics. 26, Pt, IV. Sec. II, 14-16.
153. (and Bose, S. S. and Khanna, K. L.) : Note on the optimum shape and size of plots for sugarcane experiments in Bihar. (Statistical notes for agricultural workers, No. 24). *Ind. Four. Agri. Sci.* 9. 807-816.
154. (and Chakravarti, S. C. and Bose, S. S.) : Complex cultural experiment on rice. (*Abstract*) *Proc. Ind. Sci. Cong. (Calcutta) Sec. Agriculture*. 25, III; 220.
155. (and Nair K. R. and Chakravarti, S. C.) : A 10×10 quasi-factorial experiment at Chinsurah with 100 strains of rice.

(Abstract) *Proc. Ind. Sci. Cong. (Lahore)* Sec. Agriculture. 26,
Pt. III, Sec. IX. 199.

1940

156. Application of statistical methods in physical anthropometry (appears as part of "Discussions on the application of statistical methods in anthropometry", *Proceedings of the Second Indian Statistical Conference*, Lahore. *Sankhyā*. 4, 594-598. Altered title "Application.....anthropological research." (Abstract) *Proc. Ind. Sci. Cong. (Lahore)*. 26, Part IV, Sec. VIII, 23.
157. Anthropological observation on the Anglo-Indians of Calcutta, Part III, Statistical analysis of measurements of seven characters. *Rec. Ind. Museum*. 23, 151-187.
158. Characteristic features of rain storms and river floods in Orissa *Sankhyā*. 4, 601-602.
159. Discussion on planning of experiments. *Sankhyā*. 4, 530-531.
160. Errors of observation in physical measurements. *Science and Culture*. 5, 443-445.
161. Rain storms and river floods in Orissa (with a map). *Sankhyā*. 5, 1-20.
162. (Report on the) sample census of the area under jute in Bengal in 1940. Submitted to the Indian Central Jute Committee, 1941. Proc. 2nd Indian Statistical Conference [with minor alterations and omission of the detailed tables] *Sankhyā*. 29B, 1967, 81-182. Published in book form by Stat. Pub. Soc. 1968. ii, 102p.
163. (and Nair, K. R.) : Simplified method of analysis of quasi-factorial experiments in square lattice with a preliminary note on joint analysis of yield of paddy and straw. (Statistical notes for agricultural workers, No. 25). *Ind. Four. Agri. Sci.* 10, 663-685.
164. (and Sen, Satyabrata) : Fertility rates based on a sample survey. *Sankhyā*. 4, 601.

1941

165. Note on random fields. *Science and Culture*. 7, 54.
166. On non-normal fields. (Abstract) *Proc. Ind. Sci. Cong. (Banaras) Maths & Stat.* 28, Section I Pt. III, 12.

167. Statistical note on nutritional investigations in college hostels in Calcutta. *Sankhyā*. 5, 439-448.
168. Statistical report on the rupee census— Mathematical Appendix. (Revised). *Report on Currency and Finance*, 1940-41, Reserve Bank of India, 49-55.
169. Statistical survey of public opinion. *Modern Review*. 69, 393-397.
170. (and Bose, C.) : Correlation between anthropometric characters in some Bengal castes and tribes. *Sankhyā*. 5, 249-269.
171. (and Nair, K. R.) : Statistical analysis of experiments on differential Limen values for lifted weights. *Sankhyā*. 5, 285-294.

1942

172. Sample survey of public opinion. (*Abstract*) *Proc. Ind. Sci. Cong.* (Baroda). *Maths and Stat.* 29, Pt. III, Sec I, 15. *Sankhyā*. 6, 1943, 251.
173. Sample surveys. Presidential Address, Section of Mathematics and Statistics, Indian Science Congress, Baroda, 1942. (*Abstract*) *Proc. Sci. Cong.* 29, Part II, 25-46. *Science and Culture*. 7, No. 10 (Supplement); 1942 April, 1-2.
174. Statistical definition of standard yield of crops. *Sankhyā*. 6, 97-98.
175. (and Bose, C.) : On devising an efficient sampling technique for forecasting the mean value of a variable. (*Abstract*) *Proc. Ind. Sci. Cong.* (Baroda). *Mathematics and Statistics*. 29, Pt. III Sec. 1, 14. *Sankhyā*, 6, 251-252.
176. (and Gupta, K.) : Enquiry into the family budgets of labourers in Bengal. (*Abstract*) *Proc. Ind. Sci. Cong.* (Baroda). *Maths & Stat.* 29, Part III, Sec. I, 15. *Sankhyā*, 6, 1943, 252.
177. (and Mathew, N. T.) : On the rupee census problem. (*Abstract*) *Proc. Ind. Sci. Cong.* (Baroda). *Maths & Stat.* 29, Pt. III, Sec. I, 14-15.

1943

178. Enquiry into the prevalence of drinking tea among middle-class Indian families in Calcutta, 1939. (*Studies in sample*

- Surveys). *Sankhyā* 6, 283-312.
79. (and Ghosh, B. N.) : Statistical analysis of data relating to incidence of pests and diseases on different varieties of sugar-cane *Proc. Indian Statistical Conference*, Calcutta, 1943. (*Abstract*) *Sankhyā*. 6, 349.
- 1944
80. [Editorial Note] to "The stability of the income distribution by Harro Bernardelli". *Sankhyā*. 6, 362.
81. Multi-stage sampling. (*Abstract*) *Proc. Ind. Sci. Cong. (Delhi) Maths. & Stat.* 31, Pt. III, Sec. I, 3-4.
82. On large-scale sample surveys. *Phil. Trans. Roy. Soc. London, Series B*, 231, 329-451.
83. Organisation of statistics in the post-war period. *Proc. Nat. Inst. Sci. India*. 10, 69-78.
- 1945
84. Report on the Bihar crop survey, Rabi season, 1943-44. Submitted to Bihar Govt. *Sankhyā*. 7, 29-106.
- 1946
85. Bengal famine : the background and basic facts. (Paper read at East-Asia Association at the Royal Society 25 July 1945). *Asiatic Review*. October 1946, 7p.
86. A direct method of estimating total production of crops. (*Abstract*) *Proc. Ind. Sci. Cong. (Bangalore) Stat.* 33, Part III, Sec II, 17.
87. Distribution of the Muslims in population of India. *Sankhyā* 7, 429-434.
88. Recent experiments in statistical sampling in the Indian Statistical Institute (with discussion). *F. Roy. Stat. Soc. Series A*, 109, 325-378. *Sankhyā*. 20, 1958, 329-397. *Experiments In Statistical Sampling in the Indian Statistical Institute*, Asia Publishing House and Statistical Publishing Society. 1961, 9, 70p.
89. Sample surveys of crop yields in India. *Sankhyā*. 7, 269-280.

190. Use of small-size plots in sample surveys for crop yields. *Nature*. 158, 798-799.
- 191 (and Majumdar, D. N. and Rao, C. R.) : Biometric analysis of anthropological measurements on castes and tribes of the United Provinces. (*Abstract*) *Proc. Ind. Sci. Cong. (Bangalore) Anthropology & Archaeology*. 33, Part III, Sec. 8, 138.
192. (and Mukherji, R. K. and Ghose, A.) : Sample survey of after-effects of the Bengal famine of 1943. *Sankhyā*. 7, 337-400. '*Famine and Rehabilitation in Bengal*'. Calcutta, Statistical Publishing Society, 1946, 1-63p.

1947

193. On the combination of data from tests conducted at different laboratories. Summary of lecture reported by Tucker, J. (Jr.). *ASTM Bull.* 144, 64-66.

1948

194. Report on tour of Canada, U.S.A. and U.K. October 15 to December 15, 1946. *Sankhyā* 8, 403-410.
195. Walter A. Shewhart and statistical quality control in India. *Sankhyā*. 9, 51-60.

1949

196. Historical note on the D^2 -statistic, Appendix 1. Anthropological Survey of United Provinces, 1941 : a statistical study. *Sankhyā*. 9, 237-239.
197. Statistical tools in resource appraisal and utilization. UN, 1-14p. *Proc. UN Scientific Conference on the conservation and utilization of resources*. 17 Aug.-6 Sept. 1949, Lake Success, New York. Vol. 1 (Plenary Meetings), 196-200p.
198. United Nations. Economic and Social Council. Sub-commission on statistical sampling. Report to the statistical commission on the second session of the sub-commission on statistical sampling (held from 30 August to 11 September 1948) [Chairman : P.C. Mahalanobis] *Sankhyā*. 9, 377-398.
199. (and Majumdar, D. N. and Rao, C. R.) : Anthropometric

survey of the United Provinces, 1941 : a statistical study.
Sankhyā, 9, 90-324.

1950

200. Cost and accuracy of results in sampling and complete enumeration. *Bull. Int. Stat. Inst.* 32 (2), 210-213.
201. Syllabus for an advanced (Professional) course in Statistical Sampling. *Sankhyā*. 10, 152-154. [Part of Appendix 'A' of Unesco. Subcommission on statistical sampling. Report on the 3rd session. *Sankhyā*. 10, 129-158]
202. Why statistics ? General Presidential Address, Indian Science Congress, Thirtyseventh Session, Poona. (2 January 1950). *Proc. Ind. Sci. Cong. (Poona)*. 37, Pt II, 1-32. *Sankhyā*. 10, 195-228.

1951

203. In memoriam. Abraham Wald. *Sankhyā*. 12, 1-2.
204. Professional training in statistics. *Bull. Int. Stat. Inst.* 33(5), 335-342.
205. Role of mathematical statistics in secondary education. *Bull. Int. Stat. Inst.* 33(5), 323-334.
206. (and Sengupta, J.M.) : On the size of sample cuts in crop-cutting experiments in the Indian Statistical Institute, 1939-1950. Appendices A & B, *Bull. Int. Stat. Inst.* 33(3), 359-404.

1952

207. National income, investment and national development. Lecture delivered at the National Institute of Sciences of India, New Delhi, 4 October 1952. *Talks on Planning*. Asia Publishing House and Statistical Publishing Society, 1961. 9-12p.
208. Some aspects of the design of sample surveys. *Sankhyā*. 12, 1-7.
209. Statistical methods in national development. The Thirteenth Jagadish Chandra Bose Memorial Lecture, Bose Institute, Calcutta, 30 November, 1951. *Science and Culture*. 17, 497-504.

210. National Sample Survey : General Report No. 1 on the first round, October 1950-March 1951. Submitted to the Government of India, 1952. *Sankhyā*. 13, 47-214.

1953

211. Some observations on the process of growth of national income. *Sankhyā*. 12, 307-312.
212. (and S. B. Sen) : On some aspects of the Indian national sample survey. *Bull. Int. Stat. Inst.*, 34(2), 5-14. (Spanish translation : Sobre algunos aspectos de la encuesta nacional de la India por muestras. *Estadística*, 55, 260).

1954

213. Foundations of statistics. *Dialectica*, 8, 95-111. *Sankhyā*. 18, 1957, 183-194.
214. Studies relating to planning for national development. Address delivered on the occasion of inauguration by Prime Minister Jawaharlal Nehru of the *Studies relating to Planning for National development* at the Indian Statistical Institute, Calcutta, 3 November, 1954. *Talks on Planning*, Asia Publishing House and Statistical Publishing Society, 1961. 13-18.

1955

215. Approach to planning in India. Based on a talk broadcast from All India Radio, 11 September, 1955. *Talks on Planning*, Asia Publishing House and Statistical Publishing Society, 1961, 47-54.
216. Approach to operational research to planning in India. *Sankhyā*. 16, 3-62. *An Approach of Operational Research to Planning in India*, Asia Publishing House and Statistical Publishing Society, 1963, vi, 168p.
217. Draft plan-frame for the Second Five-year Plan 1956-1961. *Science and Culture*, 20, 619-632.
218. Draft plan-frame for Second Five Year Plan, 1956/57-1960/61 : recommendations for the formulation of the Second Five Year Plan. Submitted to the Government of India, 17 March, 1955. *Sankhyā*. 16, 63-90. Published as "recommendations

for the.....plan" [in] *Talks on Planning*, Asia Publishing House and Statistical Publishing Society, 1961, 19-46p.

1956

219. Agricultural statistics in relation to planning. Address delivered at the Ninth Annual Meeting of the Indian Society of Agricultural Statistics, 7 January, 1956. *Four. Ind. Soc. Agri. Stat.* 8, 5-13.
220. The Geological, Mining and Metallurgical Society of India, Calcutta. Address delivered at the Thirty Second Annual General meeting of, 28 September 1956. *Quarterly Journal of the Geological, Mining and Metallurgical Society of India.* 28, 87-88.

1957

221. Statistics, a survey. (University teaching of social science, No. 7). Prepared and edited on behalf of the International Statistical Institute, The Hague. Paris. UNESCO, 1957. 209p.

1958

222. Enfoque de la planeacion en la India. *Trimestre Economico.* 25, 654-663.
223. Industrialization of underdeveloped countries—a means to peace. Paper presented at the Third Pugwash Conference at Kitzbuhel-Vienna, Sept. 1958. *Bulletin of the Atomic Scientists.* 15(1), 1959, 12-17, 46. *Sankhyā.* 22, 1960, 173-180. *Talks on Planning*. Asia Publishing House and Statistical Publishing Society, 1961. 125-136 (with appendix).
224. Industrializatsiya—klyuch kukreplenyu nezavisimosti. (Industrialization—a key to the consolidation of independence), *Sovremennyi Vostok* (Contemporary East), No. 12, 15-18.
225. Method of fractile graphical analysis with some surmises of results. *Transactions of the Bose Research Institute* 22, 223-230.
226. Science and national planning. Anniversary address delivered at the National Institute of Sciences of India, Madras, 5

January, 1958. *Sankhyā* 20, 69-106. *Talks on Planning*. Asia Publishing House and Statistical Publishing Society. 55-92. *Science and Culture* 23, 396-410.

227. Some observations on the 1960 world census of agriculture. *Bull. Int. Stat. Inst.* 36(1), 214-221, (Spanish translation : "Algunas observaciones sobre el censo agropecuario mundial de 1960", *Estadística*, March 1960, 11-31).

1959

228. Heralding a new epoch. [in] A study of Nehru : edited by Rafiq Zakaria, 1959, 309-320. *Talks on Planning*, Asia Publishing House and Statistical Publishing Society, 1961. 1-8p.
229. Izuchenie problem industrializatii slaborazvitikh stran. (Study of the problems of industrialization in the underdeveloped countries). *Sovremennyi Vostok* (Contemporary East), No. 9. English translation in *Talks on Planning*, Asia Publishing House and Statistical Publishing Society, 1961. 137-142p.
230. Need of scientific and technical man-power for economic development. Based on a talk broadcast from All-India Radio 23 September 1959. *Talks on Planning*. Asia Publishing House and Statistical Publishing Society, 1961. 143-146.
231. Next steps in planning. Anniversary address, delivered at the National Institute of Sciences of India, New Delhi, 20 January 1959. *Sankhyā* 22, 1960, 143-172, *Talks on Planning*. Asia Publishing House and Statistical Publishing Society 1961. 1-8.
232. Problems of economic development in India and other underdeveloped countries in relation to world affairs. *Bulletin of the International House of Japan*. 3, 10-15.
233. Review of recent developments in the organisation of science in India. Presented at the 6th General Assembly and Scientific symposium held under the auspices of the World Federation of Scientific Workers, Warsaw, 1959. *Vijnan Karmee*. 11, 13-27.
234. Unemployment and underemployment. Address delivered as the Sectional Chairman of the Second All-India Labour Economics Conference, Agra, January 1959, *Indian Journal*

of Labour Economics. 2, 39-45. *Talks on Planning.* Asia Publishing House and Statistical Publishing Society, 1961, 147-152. Also *TP*-1961.

235. (and Das Gupta, A.) : The use of sample surveys in demographic studies in India. UN. World Population Conference, Rome, 1954. E/Conf. 13/418. Vol. VI, 363-384.

1960

236. Economic development of Afro Asian countries. (Prepared for Bandung Conference, April 1955). Appendix to 'Industrialization of undeveloped countries—a means to peace' by P.C. Mahalanobis. *Sankhyā.* 22, 181-182.
237. Labour problems in a mixed economy. Presidential address delivered at the Third All-India Labour economics Conference, Madras, 2 January 1960. *Indian Journal of Labour Economics.* 3, 1-8. *Talks on Planning.* Asia Publishing House and Statistical Publishing Society, 1961. 153-159.
238. Method of fractile graphical analysis, *Econometrica.* 28, 325-351. *Sankhyā.* 23A, 41-64.
239. Note on problems of scientific personnel. Draft recommendations placed before the Scientific Personnel Committee, 24 March, 1960. *Science and Culture.* 27, 40-128.
240. On the use of the fractile graphical method for analysis of economic data. (*Abstract*) *Proc. Ind. Sci. Cong. (Bombay) Statistics.* 47, Pt. III. Sec. II. 23.
241. Scientific workers in the UK, USA, and USSR. *Science and Culture.* 26, 101-110.
242. (and Lahiri, D.B.) : Analysis of errors in censuses and surveys with special reference to experience in India. *Bull. Int. Stat. Inst.* 38(2), 1960, 409-433. *Sankhyā.* 23A, 1961, 325-358.
243. Preliminary note on the consumption of cereals in India. (With 4 appendices). *Bull. Int. Stat. Inst.* 39(4), 53-76. *Sankhyā.* 25B, 1963, 217-236.

1961

244. Role of science in economic and national development. Lec-

January, 1958. *Sankhyā* 20, 69-106. *Talks on Planning*. Asia Publishing House and Statistical Publishing Society. 55-92. *Science and Culture* 23, 396-410.

227. Some observations on the 1960 world census of agriculture. *Bull. Int. Stat. Inst.* 36(4), 214-221, (Spanish translation : "Algunas observaciones sobre el censo agropecuario mundial de 1960", *Estadística*, March 1960, 11-31).

1959

228. Heralding a new epoch. [in] A study of Nehru : edited by Rafiq Zakaria, 1959, 309-320. *Talks on Planning*, Asia Publishing House and Statistical Publishing Society, 1961. 1-8p.
229. Izuchenie problem industrializatii slaborazvitikh stran. (Study of the problems of industrialization in the underdeveloped countries). *Sovremennyi Vostok* (Contemporary East), No. 9. English translation in *Talks on Planning*, Asia Publishing House and Statistical Publishing Society, 1961. 137-142p.
230. Need of scientific and technical man-power for economic development. Based on a talk broadcast from All-India Radio 23 September 1959. *Talks on Planning*. Asia Publishing House and Statistical Publishing Society. 1961. 143-146.
231. Next steps in planning. Anniversary address, delivered at the National Institute of Sciences of India, New Delhi, 20 January 1959. *Sankhyā*. 22, 1960, 143-172, *Talks on Planning*. Asia Publishing House and Statistical Publishing Society 1961. 1-8.
232. Problems of economic development in India and other underdeveloped countries in relation to world affairs. *Bulletin of the International House of Japan*. 3, 10-15.
233. Review of recent developments in the organisation of science in India. Presented at the 6th General Assembly and Scientific symposium held under the auspices of the World Federation of Scientific Workers, Warsaw, 1959. *Vijnan Karmee*. 11, 13-27.
234. Unemployment and underemployment. Address delivered as the Sectional Chairman of the Second All-India Labour Economics Conference, Agra, January 1959, *Indian Journal*

of Labour Economics. 2, 39-45. *Talks on Planning.* Asia Publishing House and Statistical Publishing Society, 1961, 147-152. Also *TP*-1961.

235. (and Das Gupta, A.) : The use of sample surveys in demographic studies in India. UN. World Population Conference, Rome, 1954. E/Conf. 13/418. Vol. VI, 363-384.

1960

236. Economic development of Afro Asian countries. (Prepared for Bandung Conference, April 1955). Appendix to 'Industrialization of undeveloped countries—a means to peace' by P.C. Mahalanobis. *Sankhyā.* 22, 181-182.
237. Labour problems in a mixed economy. Presidential address delivered at the Third All-India Labour economics Conference, Madras, 2 January 1960. *Indian Journal of Labour Economics.* 3, 1-8. *Talks on Planning.* Asia Publishing House and Statistical Publishing Society, 1961. 153-159.
238. Method of fractile graphical analysis, *Econometrica.* 28, 325-351. *Sankhyā.* 23A, 41-64.
239. Note on problems of scientific personnel. Draft recommendations placed before the Scientific Personnel Committee, 24 March, 1960. *Science and Culture.* 27, 40-128.
240. On the use of the fractile graphical method for analysis of economic data. (*Abstract*) *Proc. Ind. Sci. Cong. (Bombay) Statistics.* 47, Pt. III. Sec. II. 23.
241. Scientific workers in the UK, USA, and USSR. *Science and Culture.* 26, 101-110.
242. (and Lahiri, D.B.) : Analysis of errors in censuses and surveys with special reference to experience in India. *Bull. Int. Stat. Inst.* 38(2), 1960, 409-433. *Sankhyā.* 23A, 1961, 325-358.
243. Preliminary note on the consumption of cereals in India. (With 4 appendices). *Bull. Int. Stat. Inst.* 39(4), 53-76. *Sankhyā.* 25B, 1963, 217-236.

1961

244. Role of science in economic and national development. Lec-

ral address. 4th All-India Conference on Statistical Quality Control, Madras. 7-9 December 1967). *Tech. Report No. 41/69.*

367. Royal Society Conference on Commonwealth Scientists. *Science and Culture.* 33, 149-153.

1969

268. The Asian Drama : an Indian review. *Sankhyā.* 31B, 435-458. Shorter Review in *Scientific American.* 221(1), 1969 July, 128-134. Longer version *Econ. & Pol. Weekly,* 4(28/30); Special Number. July 1969; 1119-1132. July 1969.
269. Extensions of fractile graphical analysis. *Proc. International Conference on Quality Control,* Tokyo, ICQC, 1969, 515-518.
270. (with D.P. Bhattacharyya) : Growth of population of India and Pakistan ; 1800-1961. General Congress, 1969, International Union for Scientific Study of Population, London. Tech. Report No. Demo/6/69.

1971

271. Some observations on recent developments in sample surveys. Proc. 38th Session (Washington). *Bull. Int. Stat. Inst.*, 44 (1), 247-261. Discussion 262-268.

